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CANADA: GLOBALLY COMPETITIVE THROUGH INNOVATION

I am pleased to present to Parliament the ninth report on the state of Canada's forests. This annual report provides Canadians with current information on the condition of Canada's forests and on forest-related issues of domestic and international importance. Innovation is this year's theme, and the report clearly illustrates how Canadian ingenuity is key to ensuring our continued success in the global marketplace.

There was a time when forests were viewed primarily as sources of timber, and forestry was based on the economics of harvesting. Today, management of our forests encompasses economic, environmental, social and cultural considerations. To find flexible and balanced ways to integrate all factors, Canada must continually reexamine and adjust its policies, and engage its collective ingenuity.

As this year's state of Canada's forests report shows, the sector is addressing the challenges of sustainable forestry in innovative ways. In fact, Canada leads the world in many areas of sustainable forest management. We have some important Canadian stories to tell, and we must tell them—clearly and effectively—to both domestic and international audiences, while we continue to work to ever improve how we manage our forests.

It is also vitally important that the sector continue to develop and deploy new technologies. Through innovation in science and technology, we can continue to expand the value-added aspect, and we can address issues such as climate change, in which the role of forests is becoming increasingly evident. By so doing, we will create new business and employment, develop new markets, increase our economic and technological sophistication, and generate greater trade.

As we enter the new millennium, Canada must become the world's "smartest" natural resources developer, user and exporter: the most high-tech; the most environmentally friendly, the most socially responsible; the most competitive and productive. By using science and technology wisely, we can show the world that it is possible to marry our social, environmental and economic objectives, and create new markets, products and opportunities at the same time.

This year, the Canadian Forest Service (CFS) of my department is celebrating 100 years of helping the Canadian forest sector to meet the increasingly complex challenges of forest management. The CFS will continue to work closely with the sector to find creative solutions. I wish to express my appreciation to the many past and present CFS employees, who have made Canada a recognized global leader and innovator.

Ralph Goodale
Minister of Natural Resources Canada

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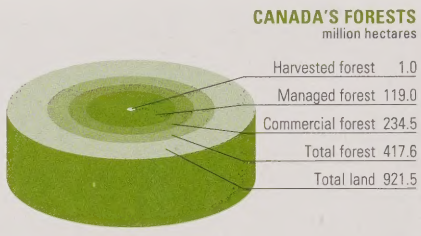
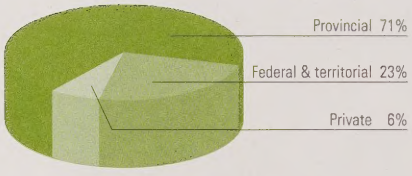
CANADA'S FORESTS:
AN OVERVIEW

Canada is symbolized by the abundance of its natural resources and, in particular, by the vastness of its forests—nearly half the nation's land area. Our forests are part of our heritage and national identity. Canadians believe that our forests come to us as a legacy to be sustained and passed on. We also appreciate that these living, self-regulating and life-supporting ecosystems provide a wide array of ecological and environmental services, as well as a number of economic and social benefits ranging from the spiritual to the material. In addition, we consider forests instrumental in the realization of our aspirations as a society and a nation.

Canada accounts for approximately 10% of the Earth's forest area. Of Canada's 417.6 million hectares of forest, 235 million hectares are considered commercial forests, capable of producing timber and a variety of other benefits, including maple products, Christmas trees and specialty craft products. Currently, 119 million hectares (28.5% of the total forest area) are managed primarily for timber, while the remaining commercial forests have not been accessed or allocated for timber. (Roughly 1 million hectares, or 0.4% of Canada's commercial forests, are harvested each year.) The non-commercial forest land is made up of open forests comprising natural areas of small trees, shrubs and muskeg.



Ninety-four percent of Canada's forests are publicly owned and are overseen by governments. Seventy-one percent of the forests are under provincial jurisdiction, 23% are under federal jurisdiction (some managed by or in cooperation with the territorial governments), and the remaining 6% are in the hands of an estimated 425 000 private landowners.



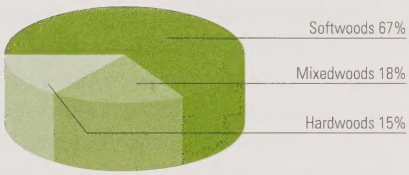
Under the Canadian Constitution, the provinces retain responsibility for matters of forest management. In recognition of the broad spectrum of forest users, provincial government agencies seek public views and work closely with forest industries, Aboriginal groups and environmental organizations to incorporate recreational, social, wildlife and economic values into forest management planning and decision making. Each province has its own legislation, regulations, standards and programs through which it allocates public forest harvesting rights and management responsibilities. In the Northwest Territories, the responsibility for resource management, including that of forests, has been transferred from the federal government to the territorial government. A similar transfer is being negotiated with the Yukon Territory.

Most provinces now require forest companies to consider all foreseeable implications of their activities before they harvest on Crown lands, and to minimize any adverse impacts on soil, wildlife and even climate.

Of the total Canadian land area south of the northern tree line, well over 80% is forested. In ecological terms, there are eight forest regions in Canada, ranging from the towering coastal rainforests in British Columbia to the sparse and slow-growing forests at the Arctic tree line. Each region comprises a unique distribution of plant and animal species, as demonstrated by the estimated 180 species of trees that can be found across the country. Of Canada's forests, 67% are softwoods, 15% are hardwoods, and 18% are mixedwoods. Canada can be further described as having 15 terrestrial ecozones, 194 ecoregions and more than a thousand ecodistricts. This array of ecosystems provides diverse habitats for an estimated 140 000 species of plants, animals and microorganisms (excluding viruses).

The average life span of Canada's forests decreases from west to east, with those living past 160 years common only in the west. These differences reflect natural variations in species longevity and disturbance frequencies. Most of our forests grow in even-aged stands that evolve as a result of major disturbances, such as fire (the most dominant disturbance in western Canada) or insect outbreaks (historically associated with more eastern Canada). Each year, fire or insect outbreaks affect several million hectares of our forests.

CANADA'S FOREST TYPES



Lastly, Canadians recognize the importance of biodiversity conservation and the need to protect specific areas because of their unique ecological features and other values. In Canada, unique representative landscapes are being maintained through designation as "protected areas," the definition of which is based on the widely accepted framework of the World Conservation Union *(see page 84)*. In 1995, approximately 7.6% of Canada's forest land was protected by legislation, in addition to the forests protected by provincial policies and operating guidelines.

In 1996, 20 million Canadians aged 15 years and over, or 84.6% of the Canadian population, participated in one or more nature-related activities. This represents a total of 1.5 billion days. Expenditures by Canadians on nature-related activities in Canada that year amounted to $11.0 billion, an average of $549 per participant.

Source: Environment Canada

YEAR IN REVIEW: 1998–1999

Many of the events or announcements reported in this year's review reflect Canada's continued efforts to promote the sustainable management of forests—our own and those of other nations throughout the world. Those efforts took various forms: programs designed to increase public awareness and participation; worker training programs; tax incentives for forest landowners; and consultations and information exchanges at the regional, national and international levels. The period June 1998 to March 1999 was also marked by some historic and ground-breaking developments—changes in forest management responsibilities, innovative approaches to business, and new methods of forest management. As well, the period may be remembered for other, less positive, developments—the natural disasters and potentially devastating predators that impacted Canada's forests, and the actions and events that affected our forest industries and the livelihood of many of our citizens.

MANAGING FORESTS SUSTAINABLY

By September 1998, the **Ontario** Woodlot Association, its partners and the Ontario Ministry of Natural Resources had more than 7 000 wooded properties with management plans recognized under the Managed Forest Tax Incentive Program. Together, the properties account for at least 404 700 hectares of privately owned forests. The woodlot owners are managing their land for objectives ranging from wildlife enhancement to harvesting, based on their personal goals.

In October 1998, the **Yukon** government released a strategy for the development and conservation of the territory's forests. *A Vision for Yukon Forests* is a key component of the management regime that is tentatively expected to take over from the federal government on April 1, 2000, and it will guide the legislation, regulations and processes to be drafted by the territorial government. The strategy reflects Yukon values and concerns and is the result of extensive consultation involving communities, First Nations, environmental organizations and industry representatives. It includes:

- 11 immediate actions to stimulate the forest economy, to better protect forest ecosystems, and to promote community-based decision making;
- 42 specific objectives (e.g., developing a new lumber inspection system and setting up a boreal forest research network); and
- an ecosystem management approach that incorporates community-level plans that respect both traditional and scientific knowledge.

In October 1998, the Hay River Dene Reserve was the site of the **Northwest Territories**' first conference on forestry. "Northern Forests, Northern Challenges: Establishing a Cooperative Approach to Forest Development" was initiated in response to the increasing interest of northern communities in management of the boreal forest. Roughly 150 participants attended the conference, representing communities, governments, Aboriginal groups, industry, environmental organizations and other agencies. The conference was followed by two days of workshops on such

issues as modern forest management practices, ecology of the boreal forest, cultural and socio-economic use of the forest, political and regulatory issues, training and employment, and business opportunities. A full-day field trip to selected communities enabled delegates to learn more about regional forest management activities in the Northwest Territories.

The 90th annual general meeting of the **Canadian Institute of Forestry**, hosted by the Ottawa Valley Section in October 1998, attracted participants from all parts of Canada and from other countries, including the United States (USA), Italy, the People's Republic of China, Indonesia, Japan, the Ivory Coast, the Republic of Korea and Mexico. The theme of the meeting was world trends and their effects on Canadian forest practices. Speakers provided delegates with information on topics ranging from the evolution of environmental awareness and the impacts of certification and ecolabeling, to fibre availability and the competitiveness of the Canadian forest industry.

The tenth meeting of the Montréal Process Working Group on **Criteria and Indicators** (C&I) for the Conservation and Sustainable Management of Temperate and Boreal Forests was held in Moscow, Russian Federation, in October 1998. The principal reasons for the meeting were to review the draft brochure *Forests for the Future—Montréal Process Criteria and Indicators*, to review the second report of the Technical Advisory Committee on definitions and rationale statements for the C&I, and to discuss the preparation of a further report on the framework of C&I. As well, representatives from the 12 participating countries shared their experiences in implementing the C&I.

In the fall of 1998, the Government of **Newfoundland and Labrador** appointed a Cabinet Committee that conducted a series of public consultation forums on outdoor rights. The principal concerns were prioritization of rivers and natural resources. Various stakeholders praised the public involvement process that had been established for forest management planning and suggested it as a provincial model. (A report on the consultations will be available in mid-1999.)

Fall 1998 brought several significant changes to legislation and regulations in **Nova Scotia**. For example, amendments to the Forests Act were passed (but not proclaimed) that will enable the Minister of Natural Resources to:

- establish a sustainable forestry fund and apply sustainable forest management principles to forest management programs throughout the province;
- apply regulations governing wildlife habitats, watercourses, wetlands and other significant resources to privately and publicly owned land;
- require individuals who carry out industrial forest harvesting on privately owned lands to provide certain information;
- enter into agreements with forest products buyers to more effectively manage the province's forest lands;
- require certain registered wood buyers to submit wood acquisition plans to the Minister for approval; and
- expand the enforcement powers of the Department and permit conservation officers to inspect forestry operations and, if warranted, to issue orders.

In 1998, the Forest Partnership Council (FPC) in **Prince Edward Island** (P.E.I.) developed a Forest Contractors Code of Practice proposal that recommends regulated standards for the commercial harvest of the province's private lands. (The Council is a volunteer organization that has representation from sawmill owners, woodlot owners, harvest contractors, forest trainers, environmental groups and government.) Commercial contractors account for at least 95% of the Island's annual forest harvest. If industrial

standards are set, contractors cutting on private land will be required to adhere to business standards ensuring the fair treatment of landowners. In addition, landowners will receive forest management advice prior to the harvest and, if desired, financial assistance for reforestation and other forest management treatments. However, before implementing the regulations under the amended Forest Management Act, the Province asked the FPC to conduct additional public and stakeholder consultations on the Forest Contractors Code of Practice recommendation. From June to September 1998, the Council held stakeholder and three province-wide consultations. Based on the concerns and suggestions raised at these sessions, the Council revised its proposal and presented its final recommendations to government in November 1998. The FPC's proposal is currently before the provincial legislature's Standing Committee on Agriculture, Forestry and the Environment for further public and stakeholder consultations. (The Standing Committee will issue its final recommendations later in 1999.)

In 1998, P.E.I. began preparations for a comprehensive land-use inventory that will begin in 1999 and take four years to complete. The inventory will provide benchmark information on a wide variety of resources, and will offer accurate and up-to-date information for planners involved in such activities as forest management planning and transportation planning. As well, the information will be available to resource users and the public on the Internet.

The **Quebec** Department of Natural Resources (MRN) conducted an update of the forest system in 1998. In the fall, it initiated a regional consultation process throughout the province to guide the government in determining its directions and priorities. This consultation process provided an opportunity for many individuals, municipalities, businesses and organizations concerned about forest management to convey their expectations. (The MRN released the results of this process in the spring of 1999.)

In January 1999, the Canadian Forestry Association designated La Mauricie, Quebec, as **Forest Capital of Canada** for 2001. Each year, the Association designates a deserving community. Swan River, Manitoba, and Kenora, Ontario, were the Forest Capitals of Canada for 1998 and 1999, respectively. Northwestern Ontario will be the Forest Capital in 2000.

In January 1999, the Ministry of Forests in **British Columbia** (B.C.) announced that the provincial government and the Private Forest Landowners Association had agreed to collaborate in protecting public values, such as water quality, fish habitat and critical wildlife habitat, on roughly half the province's privately managed forest land. (Collectively, members of the Association own more than 90% of the 920 000 hectares of privately managed forests in the province.) Under the terms of the agreement, participating landowners will be expected to meet results-based standards that are designed to protect public values while respecting private property rights. In return, the owners will receive an annual tax break of $3.6 million from the Province, which hopes to encourage more people to invest in managing their land for forestry.

Under an agreement in principle signed with the federal and British Columbian governments in January 1999, the **Sechelt First Nation** north of Vancouver will obtain $42 million from the Province and will give up its tax-exempt status within 12 years. Under the proposed treaty, band members will receive 933 hectares of urban and rural land, and will share in half the rights to forest and gravel revenues from one of the parcels of urban land.

February 1999 saw the announcement of incentives intended to encourage the sustainability of private woodlots in **New Brunswick**. One of the most significant initiatives provides woodlot owners with a rebate on their property tax if their land is operated under a forest management plan. In addition, the government doubled the

silviculture financing on private woodlots, and expanded the education programs and services available to private woodlot owners. The Province also implemented a closer monitoring system to enable marketing boards to update their wood supply analysis on an annual basis.

In March 1999, **P.E.I.** developed a concept for an innovative approach to Crown land forest management. If the concept is successful and receives public support, the government will incorporate "Value Zoning" on all Provincial Forest lands. (For example, Provincial Forests along streams would be managed primarily to protect water quality; wildlife and timber values would be treated as secondary and tertiary values, respectively.) The Value Zones would be depicted on maps available on the Internet, which would enable communities and the public to see where and how the government plans to manage areas within Provincial Forests, and would enable communities to determine where ecotourism could be encouraged.

In March 1999, the **Ontario** Ministry of Natural Resources announced a new land-use strategy, the Ontario Forest Accord and a $30-million trust fund. These three announcements will increase the amount of protected areas, improve the economic climate of the forest industry, and enhance fish and wildlife management.

The land-use strategy, known as "Ontario's Living Legacy," added 2.4 million hectares of protected areas to the province. (Establishment of the new protected areas and parks have been agreed to through commitments under the Ontario Forest Accord, and some financial support will be provided through the trust fund.) The strategy will also introduce new land-use concepts for Crown land in northern Ontario and will enhance existing land-use designations. *(See page 47.)*

The "1999 Ontario Forest Accord–A Foundation for Progress" makes the forest industry and the environmental movement partners in the protection of natural features. The Accord supports completion of a representative system of parks and protected areas on 12% of the planning area, and it provides a mechanism for limited future expansion by mutual agreement. (The new protected areas will exclude logging, mining and hydroelectric development.) The Accord also provides for a forest science partnership to look into increasing the growth and yield of Crown forests.

The Living Legacy Trust supports the agreed-upon implementation strategies of the Forest Accord. The Trust will provide $21.5 million to cover the lost use of existing forest roads and bridges, improve multipurpose resource access, develop forest management opportunities in the far north, enhance forest science, increase forest employment by improving the quality and quantity of wood supply from Crown forests, and encourage the manufacturing of value-added wood products. Another $7 million from the Trust will be used to improve the planning and management of fish and wildlife resources and to enhance access to hunting and fishing. It will also fund the improvement of fish and wildlife habitat and the acquisition of scientific data on habitat and populations.

March 1999 saw the proclamation of **Saskatchewan**'s new Forest Resources Management Act and accompanying regulations. The legislation, which requires unprecedented levels of public involvement, multilevel planning, independent audits and regular monitoring, took effect in April 1999.

Development of a northern tree nursery industry began in March 1999, with the launch of a pilot project to produce 50 000 white spruce

seedlings for reforestation in the **Northwest Territories**. (The seedlings are being grown from seed stock gathered in the territories in the summer of 1998.) Reforestation activities have been increasing in the territories, reflecting a commitment to replace forests on harvested sites in a timely manner. (Upward of 500 000 seedlings will be planted in 1999.)

Woodlot owner associations in Canada reported increased provincial funding for silvicultural activities in 1998–1999, with Quebec owners receiving $34 million and New Brunswick owners receiving $8 million. The Quebec and New Brunswick woodlot owner associations also reported working with provincial governments to conduct inventories of private forest land. The Woodlot Association of Manitoba was involved in a number of other activities, ranging from promoting the establishment of shelterbelts in agricultural areas to developing educational seminars on ecotourism, producing maple syrup, and growing mushrooms, berries and herbal plants.

In 1998–1999, the **Forest Stewardship Recognition Program** awarded 36 individuals, organizations and companies for their outstanding efforts in forest management and conservation through lifetime achievements, extraordinary efforts and innovative ideas. (Launched at the National Forest Congress in May 1998, the Program is intended to promote awareness and appreciation of good stewardship, sustainable forest practices and biodiversity conservation.) Among the recipients are a property owner in southwestern Ontario who restored a marginal farm to forest by planting more than 100 000 trees over the past 40 years, a logger in Alberta who personally halted harvesting that threatened the nest of a rare northern goshawk, and a forester in northern Ontario who modified culverts at his company's stream crossings to allow easy passage for spawning fish.

COMBATTING THE FORCES OF NATURE

In September 1998, Manitoba updated its **Dutch Elm Disease** Act by introducing new regulations and guidelines aimed at improving the effectiveness of the province's Dutch elm disease program and ensuring the health of urban and rural elm populations. The regulatory changes reflect new management techniques for tree pruning, wood disposal and the use of elms as a replacement species. The Act also provides a better definition of enforcement procedures relating to the regulations, as well as revised fines for violations (e.g., up to $5 000 for individuals and up to $10 000 for businesses).

A **European gypsy moth** infestation in portions of Vancouver Island, B.C., led to the introduction, in October 1998, of restrictions aimed at preventing the spread of the pest. The Canadian Food Inspection Agency monitored vehicles leaving the restricted area to ensure that no masses of moth eggs were unknowingly transported in nooks or crannies of the vehicles (e.g., on the wheel rims). The beige egg masses, which are roughly the size of a quarter, eventually develop into moths that eat the leaves of many hardwood trees.

The **ice storm** that hit southern Quebec in January 1998 severely damaged the province's forests, particularly those that are privately owned. (Forests in eastern Ontario and southern New Brunswick also were affected by the storm.) More than a third of the areas affected experienced a level of damage ranging from severe to very severe. Special programs were set up in November 1998 under federal–provincial cost-sharing arrangements on behalf of the 30 000 owners of private woodlots and farms affected by the storm. These programs are delivered through private woodlot improvement agencies, and they provide for consulting and

technical services, as well as financial assistance in the restoration and rehabilitation of woodlots. The programs will expire in 2002.

In the fall of 1998, Saskatchewan began the process of developing a new overall **fire and forest insect and disease** management policy. Separate policies within the overall framework will consider wildfire, prescribed fire, and forest insect and disease management. Together, the policies will provide an integrated and ecologically sound approach to resource management and protection and will reflect changing public values.

In Canada, 25 exotic insect pests, 10 introduced fungi and 27 other exotic plant species are listed as problematic, along with the threats they pose. Some of the major invasive species include Tartarian honeysuckle in Ontario and Scotch broom in B.C.

More money was spent battling forest **fires** in Canada in 1998 than ever before. The average annual cost is generally $400 million–$500 million. In 1998, a dry winter, followed by a summer with high temperatures and frequent lightening, almost doubled the average annual area burned and drove costs up to $600 million–$700 million.

Saskatchewan had the busiest forest fire season in the history of the provincial fire organization. A total of 1 266 fires were recorded in 1998, compared to the 10-year seasonal average of 756. Spring drought codes were well above normal levels, and the situation was complicated by unseasonably high temperatures and little precipitation during the fire season. Due to extreme fire behaviour, some evacuations of communities, mine sites, tourist lodges, work camps and individual residences were necessary. In all, 649 people were moved to safe locations in 17 separate evacuations. Property loss over the season was minimal, however, considering the extreme fire behaviour experienced.

In 1998, Alberta saw wildfires consume roughly 16 times the average annual area burned over the past 10 years—roughly 12 million m^3 of wood or enough to build 235 000 average-sized homes. Mills lost up to $600 million in merchantable timber, and fire-fighting costs totalled more than $200 million. (As a result of new technology, much of the fire-damaged timber is considered salvageable, providing the dead trees are harvested within the two-year window preceding the onset of decay and/or infestation.)

The impact of forest fires was above average in the Northwest Territories in 1998, with 399 fires reported and an area of more than 2.5 million hectares burned.

In January 1999, AEF Global was granted a repayable loan of $1.4 million from the federal government (i.e., Canada Economic Development for Quebec Regions) to bring a biological insecticide to market. The biopesticide, which is derived from *Bacillus thuringiensis (B.t.)*, can be used to combat **pests** affecting agriculture, the environment and forestry. The market for the product, currently awaiting approval from the Pest Management Regulatory Agency, is estimated at $30 million in Canada and $100 million in North America.

Regulations came into effect in January 1999 as part of the federal government's efforts to keep the devastating **Asian long-horned beetle** out of Canada's hardwood forests. Under the regulations, to be allowed entry via Canadian ports, all shipments from China that are packaged in wooden crates, skids or pallets must be accompanied by a certificate proving they have been treated for the beetle. (Similar restrictions went into effect in the USA after the beetle destroyed thousands of trees in New York state and Chicago, Illinois.) To help combat the spread of the beetle, Natural Resources Canada–Canadian Forest Service (CFS) and the Canadian Food Inspection Agency developed an intensive training program for new inspectors, as well as pest

information packages for import–export companies. (In 1997, Canada imported roughly $6.2 billion in goods and services from China.)

ADDRESSING ENVIRONMENTAL ISSUES

In April 1998, the federal, provincial and territorial ministers of energy and environment agreed to a process for developing a national implementation strategy on **climate change.** Since then, 13 Issues Tables have been established to examine the impacts, costs and benefits of potential options for achieving Canada's target in reducing greenhouse gas emissions. Two Tables focus explicitly on forest sector issues. The Forest Sector Table comprises 23 members from the sector's major stakeholder groups; its mandate is to identify and prioritize opportunities for greenhouse gas mitigation within the forest sector. The Sinks Table also has significant representation from the forest sector and was created to provide advice on carbon sequestration in forest, agricultural and other sinks. To date, the Tables have conducted research and analysis in such areas as energy efficiency technology issues, bio-fuel use and forest sink options. The Tables have also held a number of meetings to determine the research being performed, the strategies for outreach, and the proposed mitigation options (to be finalized in their Options Report due in the fall).

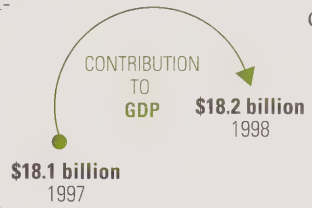
In October 1998, the federal government announced it would spend $30 million over the next three years on a public education program to address climate change. The money will go toward advertising and classroom materials intended to increase the public's awareness of climate change and its impacts; and to educate Canadians regarding the lifestyle changes they could make to help curb greenhouse gas emissions. (Under the Climate Change Action Fund announced in February 1998, a total of $150 million in funding over three years has been committed to support action on climate change. In addition to funding public education efforts, a further $56 million was allocated to the development of technologies to reduce greenhouse gas emissions; $34 million, to the analysis of options for cutting emissions; and $15 million, to research on the impacts of climate change and adaptation.)

Buenos Aires, Argentina, was the scene of the Fourth Conference of the Parties (COP4) to the United Nations Framework Convention on Climate Change (UNFCC) in November 1998. This was the first meeting of the Parties since the adoption of the Kyoto Protocol to the UNFCC in December 1997. COP4 established a work plan to address a number of issues related to the Protocol. One of the significant issues is how atmospheric carbon dioxide sequestered by forests and other categories of sinks (e.g., agricultural soils) might be included in greenhouse gas emissions reduction levels or targets established by the Protocol for the first commitment period (2008–2012). (For Canada, this means a reduction of 6% below 1990 levels.) At Kyoto, the inclusion of forests as sinks was intensely debated and was only adopted in a limited manner as a component of greenhouse gas emissions in the context of activities related to reforestation, afforestation and deforestation (RAD). The Kyoto meeting adjourned with no agreement on the definitions related to RAD. In Buenos Aires, COP4 adopted a decision to have the Intergovernmental Panel on Climate Change undertake a special report on the implications of various RAD definitions and forest management activities that contribute to enhanced sequestration of atmospheric carbon by forest ecosystems. (The Panel's report is to be completed by May 2000.)

In June 1998, the B.C. Forest Practices Board, an independent agency established in 1995, released the results of its special investigation into forest planning and practices near **streams** in coastal areas of the province. The report concluded that practices near streams have improved since the Forest Practices Code was created and that the disturbance of streams by

logging has dropped significantly since the late 1980s. It cautioned, however, that there is still room for improvement in the classification of small fish-bearing streams and in the practices near those streams. The Board has made recommendations to government and industry on how to further improve forest practices near streams and other waterways.

In June 1998, MacMillan Bloedel Ltd. announced its intention to phase out conventional **clearcutting** over five years in all of its B.C. operations and to pursue a new stewardship strategy focusing on old-growth and habitat conservation. Under the new forest plan, the intensity of logging will be limited, and a range of variable retention harvesting systems will be introduced. For example, in the stewardship zone classified by MacMillan Bloedel as "old-growth" (approximately 10% of its Crown tenures and private forest lands), the company will develop management plans based on the assumption that 70% of the old-growth forest will never be logged. Within the areas subject to harvesting, timber retention will be high, and harvest openings will be less than 1 hectare.



The International Union of Forest Research Organizations (IUFRO) held a symposium in August 1998 on integrating **environmental values** into the forest management of small properties. Forty-six participants from 16 countries attended the symposium in Vancouver, B.C. Their discussions focused on the challenges of integrating environmental values and the multiple benefits of forests into land management at a time when the overall profitability of small-scale forestry is decreasing and the number of managed forests is declining.

In the fall of 1998, Nova Scotia passed a new **Endangered Species** Act. The Act provides for the legal designation and listing of species at risk and the development of endangered species recovery plans; prohibits the killing, disturbing, selling and trading of endangered or threatened species, and protects their core habitats; and establishes a species at risk conservation fund and working group.

In December 1998, Canada became the first country to ratify a regional multinational agreement (the United Nations Economic Commission for Europe Convention on Long-range Transboundary Air Pollution on Persistent **Organic Pollutants** Protocol) that calls for a reduction in atmospheric emissions of 16 persistent organic pollutants, including dioxins. The chemicals pose serious health and environmental threats to Canada. The Protocol is the first major legally binding regional multinational agreement on hazardous air pollutants. The use of many of the substances covered by the Protocol has already been banned or restricted in Canada; however, Canadians will benefit from the Protocol because these substances continue to be used abroad and are deposited in Canada as long-range transboundary air pollutants. (The Protocol will go into effect after being ratified by 36 countries.)

In January 1999, the federal government and the Government of Quebec developed strategies to implement the Global Convention on **Biological Diversity**. The CFS, the Centre sur la biodiversité du Québec and the Entomofaune du Québec corporation agreed to a three-year partnership that will accelerate the creation of databases and other systems relating to biodiversity.

In February 1999, B.C. announced a strategy that offers additional protection for **forest species and plant communities** considered sensitive to changes in habitat. Many of these species are naturally rare, occur infrequently, or are at the limit of their natural range and are considered to be at risk. The Identified Wildlife Management

Strategy conveys additional protection to the critical habitats of these species, including their breeding, denning and feeding sites. The new provincial Strategy is designed to reduce the impacts of forest and range development on identified wildlife species within certain social and economic constraints.

In March 1999, the Government of Newfoundland and Labrador announced the establishment of a **conservation** foundation known as the "Newfoundland and Labrador Legacy Nature Trust." The Province will provide the Trust with $1 million in seed funding over a five-year period as a tangible and living legacy of the 50th Anniversary of Confederation. The Trust will fill an identified need for a non-governmental organization that can attract significant additional resources for conservation activities in Newfoundland and Labrador by accessing new sources of funding, particularly those outside the province. The Trust, in turn, will invest in the efforts of groups and organizations that develop worthwhile programs and initiatives to conserve, enhance and restore the quality of the unique natural environment of Newfoundland and Labrador.

In March 1999, the Natural Heritage Act was introduced to ensure that Alberta's **biological diversity**, as represented in the parks and protected areas network, will remain a lasting legacy. The Act amalgamates and updates protected areas legislation and will enable a long-term management system to be established with effective legislation, enforceable regulations and clear policy direction.

B.C.'s Forest Practices Code conveys general protection for most **forest-dwelling species** through its requirements for biodiversity and riparian management. In March 1999, the provincial government published a landscape-unit planning manual that will strengthen the Code's capacity to conserve the province's unique variety of plants, animals and other living organisms by maintaining key elements of forest ecosystems. The manual will also help forest managers determine the amount of old-growth and wildlife trees to conserve within B.C.'s forested ecological zones.

In March 1999, the National Round Table on the Environment and the Economy (NRTEE) hosted an international workshop in Toronto, Ontario, entitled "Domestic **Greenhouse Gas Emissions** Trading Programs: A Comparison of Progress Around the World." The workshop was organized to foster a better understanding of the strengths and weaknesses of various emissions trading programs and the possible implications for competitiveness. Speakers from government departments and research agencies in Canada, Australia, New Zealand, Norway and the USA, among other countries, presented information on their national policy processes and on the trading program designs being considered.

In May 1999, TimberWest Forest Corp. announced that it will phase out conventional **clearcutting** on private lands and Crown tenures in B.C. over the next four years in favour of variable retention harvesting. TimberWest also announced its intention to work with MacMillan Bloedel Ltd. to establish joint public advisory committees in the areas where they operate and to consult with community stakeholders on a regular basis.

PRESERVING A FOREST LEGACY

In August 1998, Young's Point Provincial Park in **Alberta** was reclassified as a Natural Heritage Site and enlarged from 1 090 hectares to almost 3 072 hectares. In addition, a detailed management plan based on public input was approved for the Elbow Sheep Wildland Park in Kananaskis Country.

August also saw the creation of Whitehorse Wildland Park near Jasper, Alberta, reclassifying the existing Cardinal Divide and Cadomin Cave Natural Areas and adding 10 940 hectares to the area protected. The Park secures the largest proportion of Harlequin Duck nesting habitat, elk range and rare plant communities on the slopes of the Cardinal Divide, and it contributes to the region's carnivore compensation program by securing travel corridors, core areas and important seasonal habitat.

A report commissioned by the Forest Alliance of **B.C.** was released in October 1998, outlining the potential impact of the Yellowstone to Yukon (Y2Y) initiative on resource-dependent communities. The Y2Y concept, which is backed by more than 100 conservation groups and by the Washington, D.C.-based Wilderness Society, involves a plan to link 2 897 contiguous kilometers from Yellowstone National Park to the Yukon Territory, in part through new protected areas. The Y2Y area of B.C. accounts for roughly half the province and 35% of its annual allowable cut. The report indicates that Y2Y could result in the loss of 80 000 direct and indirect jobs in B.C., including more than 25 000 forest sector jobs. The study also found that $800 million in provincial government revenues and $5.4 billion in provincial Gross Domestic Product could be lost annually if the plan proceeds.

In **Alberta**, approximately 728 hectares surrounding the 162-hectare site occupied by the Head-Smashed-In Buffalo Jump Interpretive Centre were designated a Provincial Historic Resource in November 1998. By protecting more land, the designation captures more of the buffalo driving lanes that were used to direct the animals toward the jump, along with archaeological information on the tools and lifestyles of the people who used the site. (Head-Smashed-In Buffalo Jump was recognized as a World Heritage Site by UNESCO in 1981.)

In the fall of 1998, **Nova Scotia** passed a new Wilderness Areas Protection Act, designating 31 new areas of Crown land as representative samples of distinct natural landscapes and ecosystems in Nova Scotia. The Act allows for the protection of these lands, with specific allowances for such activities as ecosystem management, research and education, wilderness recreation and nature-based tourism. The designations encompass 285 000 hectares (almost 20%) of Crown forest land and transfer authority for the lands from the Minister of Natural Resources to the Minister of the Environment. Under the new Act, a management plan will be prepared for each area, the development of which will include public consultation.

In December 1998, **Alberta**'s Department of Environmental Protection announced the creation of a 16 718-hectare wildland park. Bow Valley Wildland Park is located within the 18 616 hectares of land in the Bow Valley Region (near Canmore) that were recently designated under the Special Places Program. New developments, including resorts, housing, ski hills and golf courses, will be prohibited in the wildland park.

In December 1998, the **Yukon** government released its Protected Areas Strategy, as well as a two-year work plan for ensuring adequate protection of core areas in each of the territory's 23 ecoregions. In addition to protecting natural features, the Strategy identifies processes for protecting special social, cultural and heritage features. It is also expected to enhance recreational opportunities and to provide greater certainty for resource-based industries.

The amount of protected land in **B.C.** grew to 11% in January 1999 with the inclusion of 250 000 hectares in the Prince George region. The area was designated through a process by which certain portions of Crown land are allocated for resource

exploitation and others are allocated for varying degrees of protection. In addition, the government announced the protection of 80 000 hectares of northwestern B.C., and its intention to work with the Gitxsan and Gitanyow First Nations to develop park management plans for two proposed parks in the Upper Kispiox and Seven Sisters areas. The Province also announced the creation of Tantalus Provincial Park near Squamish, a 1 134-hectare area of waterfalls, low-elevation forests and rugged alpine terrain; Liumchen Ecological Reserve, a 2 190-hectare ridge above Cultus Lake; and the Yale Garry Oak Ecological Reserve, an 11.65-hectare stand of rare Garry oak trees at the south end of the Fraser Canyon.

PROMOTING ABORIGINAL PARTICIPATION IN FORESTRY

In September 1998, the Prince Albert Grand Council and the National Aboriginal Forestry Association hosted a **conference** in Prince Albert, Saskatchewan, entitled "Celebrating Partnerships." More than 150 First Nation, industry, academic and government representatives participated in the conference. Topics of discussion included many of the national forestry issues facing First Nations, ranging from Indigenous trade and development, to managing Aboriginal lands. At the meeting, the Assembly of First Nations announced that it will be taking a more active role in addressing these issues over the short term.

In October 1998, a **forest license** was granted to Echa-Peh Forest Resources Ltd.—a joint venture involving two First Nations and two private industries in B.C.—to supply 40 000 m^3 of fibre annually to local mills for the next 15 years.

In 1998, New Brunswick worked to involve Aboriginal communities in **forest harvesting** activities and was successful in negotiating one-year agreements with all 15 of the province's First Nations. (*See pages 89-91 for an article on First Nations and forests in Canada.*)

In February 1999, approximately 100 people from across the country met in Saskatoon, Saskatchewan, to share their experiences with the **First Nation Forestry Program** and to highlight their successes. The meeting provided First Nation participants with an opportunity to network with their colleagues from different parts of the country. Also, First Nation representatives made a number of presentations on program administration and management; successful projects and the importance of partnerships; and the social, traditional and economic opportunities arising from practising sustainable forest management on reserves.

The second annual report of the First Nation Forestry Program (FNFP) was released in February 1999. According to the report, in 1997–1998, the FNFP supported 208 proposals with approximately $4.75 million in federal funding. In addition, First Nations and other partners contributed roughly $11.96 million, an increase of 97% over the previous year. (The report can be viewed on the Internet at http://www.fnfp.gc.ca/rep98.)

BUILDING PARTNERSHIPS

The annual meeting of the **Canadian Council of Forest Ministers** (CCFM) was held in September 1998 in Victoria, B.C., where the ministers discussed a wide range of key international and national forestry issues. For example, they confirmed their resolve to continue pursuing an international forest convention, agreed to a cooperative approach to implementing the new National Forest Strategy, and extended the International Forestry Partnerships Program for another year. They also discussed the Kyoto Protocol, private woodlot taxation and employment in the forest sector. In addition, they reaffirmed their support for Canada's bid to host the World Forestry Congress in Québec City in 2003. (Quebec agreed at the meeting to chair the CCFM for the coming year.)

A **Memorandum of Understanding** (MOU) between the CFS and the State Forestry Administration of China was signed in Beijing during the Prime Minister's visit in November 1998. The MOU covers a broad range of forest sector interests and will be mutually beneficial from technical and economic standpoints. A bilateral steering committee will develop a work plan for activities under the MOU that could include information exchanges, scientific and technical cooperation, training, and the promotion of forest sector development and commerce.

The 19th session of the **North American Forest Commission** was held in Mexico in November 1998. (The Commission consists of senior officials from the federal forest services of Canada, Mexico and the USA. It meets every two years to exchange information on each nation's progress in implementing sustainable forest management; to discuss forestry issues of common interest; and to review the work of study groups collaborating in such areas as fire management, forest products, and insects and diseases.) At the November meeting, technical presentations were given on the relevance of traditional knowledge to sustainable forest management, the results of a field test on criteria and indicators, and the conclusions of a North American workshop on forest monitoring and assessment.

Over the first 18 months of the second phase of Canada's **Model Forest Program** (1997–2002), each of the 11 model forests developed a set of local-level indicators for monitoring and reporting on their progress toward sustainable forest management. In developing their respective sets of indicators, the model forests collaborated at the network level, sharing their knowledge, experiences and methods.

ANNOUNCING CHANGES IN THE INDUSTRY

In the fall of 1998, Industrial, Wood and Allied Workers (I.W.A.) Canada developed the High-powered Work Organization Program to promote industrial **partnerships between companies and workers**, and to increase employment opportunities and improve productivity. Under the Program, companies and the union negotiate a jointly developed strategic business plan that focuses on growth and continuous employment through such steps as shared decision making, shared information, ongoing learning and skill development, and an emphasis on growing the business.

In December 1998, the Woodlands Division of Stora Port Hawkesbury Ltd. in Nova Scotia became the first forestry operation in Canada (and only the second in North America) to receive **ISO 14001 registration** of its Environmental Management System (EMS). The woodlands EMS covers all trucking of primary forest products, as well as forest planning, road construction, harvesting and silvicultural activities performed by company and contractor personnel on company controlled lands.

Canada's pulp and paper mills operated at 87% of capacity in 1998, compared to 92% in 1997. Total shipments of pulp and paper products fell 3.4% in 1998, to 28.4 million tonnes.

In December 1998, a ruling by the U.S. Court of International Trade (CIT) upheld the June 1998 U.S. Customs **reclassification of drilled wood studs** into a tariff category covered by the Canada–USA Softwood Lumber Agreement. That decision is now being appealed. In addition, Canada placed the product classification aspect of the dispute on the agenda of the Harmonized

RECENT ANNOUNCEMENTS–Forest Products Industry

DATE	COMPANIES INVOLVED	ACTION	LOCATION	VALUE (C$)
Sept. 1998	MacMillan Bloedel Ltd. to Temple Inland Inc.	Sale	Ont.: 1 medium density fibreboard plant USA: 1 medium-density fibreboard plant	$5 million
Sept. 1998	MacMillan Bloedel Ltd. to Stone-Consolidated Corp.	Sale	Canada: 12 mills	$185 million
Sept. 1998	Stone-Consolidated Corp. to Jefferson-Smurfit Group plc	Sale	Canada: 12 mills	$185 million
Sept. 1998	Stone Container Corp. to Abitibi-Consolidated Inc.	Sale	USA: 1 newsprint mill	US$250 million
Sept. 1998	Sunpine Forest Products Ltd. to Weldwood of Canada Ltd.	Sale	Alta.: 1 processing plant, 1 sawmill and timber holdings	$100 million
Oct. 1998	MacMillan Bloedel Ltd. to Primex Forest Products Ltd.	Sale of stake in Field Sawmills Ltd. Partnership	B.C.: 1 sawmill and planer mill	$5 million
Oct. 1998	Stone Container Corp. to Abitibi-Consolidated Inc.	Sale	USA: 2 paper mills	US$250 million
Oct. 1998	Bowater Inc. to J.D. Irving Ltd.	Sale	USA: 40 000 hectares of timberland and 1 sawmill	US$250 million
Nov. 1998	Abitibi-Consolidated Inc. and BOSCUS Canada Inc. (CFL Structure Inc.)	Construction	Que.: 1 plant	$27 million
Nov. 1998	Union Camp Corp. and International Paper Co.	Merger	Worldwide	$6.6 billion
Dec. 1998	Noranda Inc. and Noranda Forest Inc. (new name: Nexfor Inc.)	Share exchange	Company spin-off	$1 billion
Dec. 1998	Noranda Inc. to Papier Masson Ltée	Sale	Que.: 1 newsprint mill	$150 million
Jan. 1999	Crestbrook Forest Industries Ltd. to Tembec Inc.	Sale	B.C.: 1 pulp and lumber mill	$70 million
Jan. 1999	Chatham Forest Products Ltd., Stone & Webster Canada Ltd. and Temple-Inland Forest Products Corp. to MacMillan Bloedel Ltd.	Sale of shares	N.B.: 1 oriented strand board (OSB) plant	$30 million
Jan. 1999	Smurfit-Stone Container Corp. to investor institution	Sale of shares	Not applicable	US$80 million

System Committee (HSC) of the World Customs Organization (WCO). (The HSC is charged with resolving classification disputes that cannot be solved through bilateral negotiations.) At the May 1999 meeting of the WCO, the HSC voted 21 to 1 in support of the Canadian position on the tariff classification of drilled studs. The USA now has the option of filing an objection, which could be considered at this fall's session of the HSC. (Canadian drilled lumber shipments to the USA are estimated at 400 million–500 million board feet per year or roughly 3% of Canadian softwood lumber shipments to the USA.)

In 1998, the Alberta Forest Products Association (AFPA) commissioned an extensive survey of its members to quantify the total impact of their industrial activity on the provincial economy in 1997. The survey resulted in sufficient data to show the direct, indirect and induced impact for several key economic indicators, including employment, wages and salaries, gross domestic product (GDP) and personal taxes. The results of the analysis indicate that the AFPA members had a substantial **impact on the Alberta economy** in 1997. For example, for every job supported by the AFPA membership, another 1.2 jobs were created, and members contributed $2.5 billion to Alberta's GDP (2.7%) through their activities in manufacturing, logging and forestry, transportation and construction.

Canadian **lumber exports to Japan** fell sharply from the first quarter of 1997 through the summer of 1998, before recovering modestly in the latter part of the year. Prices of key lumber products—J-grade spruce-pine-fir (spf) dimension lumber and hemlock baby squares—also improved

marginally in the latter part of 1998. (Hemlock baby squares, produced by B.C. coastal sawmills, are used in the construction of traditional post and beam Japanese houses, while J-grade dimension lumber, produced by sawmills in the B.C. interior and in the rest of Canada, is used in the construction of two-by-four frame housing in Japan.) The increased prices and volumes of exports were welcome, although they were still well below the levels recorded in 1996.

Source: Canadian Christmas Tree Growers Association

Canada's **Christmas tree business** benefits nearly every region of Canada and is growing year by year. According to the Canadian Christmas Tree Growers Association, the unseasonably warm temperatures in 1998 increased the number of families visiting a farm during the holiday season to select and cut their own tree. All told, more than 5 million trees, valued at approximately $60 million, were harvested in 1998. At least half of those trees were exported to destinations in the USA, Mexico, Central America and the Caribbean.

In January 1999, Quebec published an environmental compliance report on the pulp and paper sector for 1996. (In 1993, the government had adopted strict **environmental regulations** governing the pulp and paper industry in the province.) The report reveals that despite an increase in production, the sector achieved a reduction in water consumption and contaminant emissions.

In January 1999, Montréal, Quebec, was the scene of an event billed as the world's largest **annual paper exhibit**. This year's Paper Week attracted more than 450 exhibitors and 15 000 visitors from North America and from other nations with a paper industry. Many of the guest speakers shared their views on industry competitiveness and global markets, while environmental issues, such as global warming and paper recycling, were the focus of open forums.

In January 1999, Canfor Corp. of Vancouver, B.C., and Georgia–Pacific Corp. of Atlanta, Georgia, announced their intention to form a **joint company** to market their respective pulp and paper products in Japan. By teaming up, the companies hope to reduce costs (currently, they each have sales offices in Japan) and to expand their businesses by offering one-stop shopping for their complementary products.

In early 1999, in response to the recent market downturn in Japan and other Asian markets, I.W.A. Canada put together a proposal for an enhanced **marketing strategy** for Canadian forest products. The proposal, "Marketing Canada's Forest Products," suggests measures to develop new markets, invest in new products and technologies, and challenge environmental boycott campaigns. (I.W.A. Canada has since presented the proposal to federal government officials and to the Standing Committee on Natural Resources and Government Operations.) I.W.A. Canada has also been active in efforts to counter U.S. trade disputes, particularly with respect to wood products destined for the U.S. market.

In 1998–1999, the Ontario Woodlot Association developed (and will deliver) a **marketing-support program** to help woodlot owners achieve a fair return for their wood products. The marketing program is an integral part of the Forest Recovery Assistance Program (FRAP), valued at $10 million, that is administered by the Ontario Ministry of Natural Resources. Private woodlot owners in eastern Ontario whose forests were damaged in the January 1998 ice storm were able to apply to the FRAP, which will expire in March 2000.

In 1998–1999, **B.C.'s forest sector** faced some critical challenges: the collapse of key coastal export markets because of the Asian economic crisis, an excess in mill capacity, and unresolved land-use issues on the coast. In January 1999, after extensive consultations with all forest stakeholders, the Province announced the Forest Action Plan to help stabilize and modernize B.C.'s forest sector and to help industry, communities and workers move to a more diversified and sustainable future while maintaining strong environmental standards. Short-term Action Plan initiatives are directed toward bringing stability to the province's forest industry and increasing support to communities and workers in crisis. Over the long term, policy and regulatory changes also will be considered to address structural issues in the sector.

TRAINING FORESTRY EMPLOYEES FOR THE FUTURE

In June 1998, Forintek Canada Corp. and the Northern Alberta Institute of Technology entered into an agreement to involve Forintek scientists in the Wood Products Engineering Technologist Training Program. By having **scientists teach** part of the course content, the organizations hope to strengthen the education of the industry's future work force.

In July 1998, the **Sustainable Forest Management–Network of Centres of Excellence** (SFM-NCE) was renewed to 2002, with $9 million in funding over three years. Research and training are the main focus of the NCE, which is located at the University of Alberta. The research is directed toward improving Canada's forest-based economy through the development of knowledge, strategies and technologies for the management and conservation of boreal forests; and the program trains students in an interdisciplinary fashion by giving them exposure to activities outside their strict academic discipline. Last year, more than 200 students benefitted from the program.

In the fall of 1998, the Nova Scotia Forest Technicians Association and the Nova Scotia Section of the Canadian Institute of Forestry established an **education program** that is mandatory for Association members who wish to be recognized as Certified Forest Technicians. (The education program is one component of a certification program adopted by the Association in March 1998 to ensure the accountability, conduct and standards of its members.)

In January 1999, 5 Canadian universities and 10 institutions in the European Union reached an agreement that will enable master- and doctorate-level forestry students and faculty to participate in exchanges, internships, reciprocal work training programs and joint courses. The **international academic consortium** was established in response to demands from employers and the public for more broadly educated forestry professionals who understand both the local and international implications of their actions and decisions. Financial support for the Canadian partners is being provided by the Canada–European Community Program for Cooperation in Higher Education and Training and by Human Resources Development Canada.

The CFS and Alberta Environmental Protection launched an **interactive multimedia CD** in February 1999 to train fire management staff in the use of the Canadian Forest Fire Behaviour Prediction System. The system, which was developed by the CFS in conjunction with provincial fire agencies, is used across Canada and in parts of the USA. It relates environmental factors, such as weather, fuels and topography, to fire behaviour. The training and reference CD is based on a CFS training manual and is sold through the University of B.C. Press.

In 1998–1999, the Western Newfoundland Model Forest developed the Front-line **Training** Project to provide woods workers in the province with training related to environmental awareness and environmentally sensitive harvesting

practices. Training under the Project began in the spring of 1999.

The Canadian Forestry Association has designed a training program, called **"Logging for Wildlife,"** to help loggers address wildlife habitat concerns in the course of their work. The Program has already been adapted for New Brunswick, Newfoundland, Nova Scotia and eastern Ontario, and plans to expand the training to other regions of Canada were under development in 1998–1999. Hundreds of loggers in New Brunswick and Nova Scotia have already attended the Program, which is organized by the Association with the support of the CFS, the Canadian Wildlife Service, Wildlife Habitat Canada and the Canadian Wildlife Federation.

INVESTING IN THE FORESTS OF TOMORROW

In June 1998, the CFS announced funding of $4 million over four years for a **value-added research program** to be undertaken by Forintek Canada Corp. (The research program complements the value-added technology transfer programs established at Forintek by the Provinces of Quebec and B.C. in 1997.)

The Lower St. Lawrence Model Forest and Abitibi-Consolidated Inc. renewed their agreement in August 1998, giving the Model Forest rights to manage the Nicolas Riou and Lac-Métis portions of Abitibi Consolidated's private land until 2009 and enabling the Model Forest to continue its **tenant forest-farming trials**. (*See page 50.*)

The **Canadian Biotechnology Strategy** was announced in August 1998, demonstrating the federal government's commitment to the rapidly growing biotechnology sector. The new Strategy will help bring about advances in health, environmental safety and economic development. It will also further the 1983 National Biotechnology Strategy by integrating social, ethical, health, economic, environmental and regulatory considerations; addressing public information and participation; establishing a broadly based advisory committee; strengthening the business, regulatory and investment climate; and improving the government's ability to manage issues across sectors. A team of seven ministers whose portfolios most closely touch on biotechnology matters (Industry, Agriculture and Agri-Food, Health, Environment, Fisheries and Oceans, Natural Resources, and Foreign Affairs and International Trade) will manage the Strategy and address cross-sectoral issues.

September 1998 saw the creation of a **forest industry research agency coalition** ("FORCAST") intended to facilitate the sharing and development of new technologies. (To date, 10 federal, provincial and territorial governments and 13 non-governmental stakeholder organizations have joined the private, non-profit entity.) By coordinating their efforts, FORCAST members are helping to address some of the concerns raised when private- and public-sector R&D programs were curtailed in response to economic pressures.

The **National Forest Science and Technology Course of Action** was distributed to the forest science community in February 1999, and FORCAST began championing its implementation. The Course of Action can be viewed on the Internet at http://nrcan.gc.ca/cfs/proj/sci-tech/action/index_e.html.

In November 1998, the Alberta Forest Products Association and Alberta Economic Development announced the establishment of a province-wide **wood residue database** (to be accessible on the Internet in mid-1999) that will provide users with

information regarding the volume, type and proximity of residues (e.g., sawdust, log-yard breakage, shavings and other materials). Recent technological advances have created new uses for residues, and the information provided in this database will facilitate the research into potential products and markets.

In December 1998, MacMillan Bloedel Ltd. announced that it had developed a new and cost-effective logging technique in its efforts to phase out clearcutting. The technique involves climbing a tree, cutting off the branches, painting the top to make it visible from the air, and cutting around the trunk deeply enough to enable a helicopter pilot to grapple the tree and snap it off before flying it to a roadside landing. The company has tested the **new logging technique** successfully on Vancouver Island, B.C., and expects to use it on a larger scale in 1999.

In December 1998, eight recipients were announced for 1998–1999 under the Research Partnerships Program of the CFS and the Natural Sciences and Engineering Research Council (NSERC). The CFS–NSERC support for these new **university-based research projects** exceeds $400 000. The projects undertaken by these recipients address many issues related to sustainable forest management, such as forest ecology, pest management, effects of forest practices, biotechnology, modeling and wood dynamics. (A new Research Partnership Program involving the CFS, NSERC and the Social Sciences and Humanities Research Council [SSHRC] was announced in October 1998. The inclusion of the SSHRC increases the overall support for the Program and provides a social sciences and humanities component to the proposals.)

A major research activity at the Pulp and Paper Research Institute of Canada (Paprican) is finding ways to improve the utilization of resources, and to reduce or eliminate the production of materials discharged as solid, liquid or gaseous emissions. In 1998, Paprican commissioned two **state-of-the-art pilot plants**. The new multistage bleaching plant was installed to develop system-closure procedures for pulp manufacturing. The new paper machine will enable scientists and engineers to evaluate strategies for reducing or eliminating emissions by recovering and reusing water in the papermaking process. The paper machine has been designed to run at speeds of up to 2 500 m per minute, and it offers a variety of pressing processes for water removal, as well as a novel high-intensity drying system.

In January 1999, Iogen Corp. received a $10-million loan from Technology Partnerships Canada and Natural Resources Canada to develop a technology aimed at **reducing greenhouse gas emissions**. The biotechnology firm is involved in research to convert farm waste (e.g., straw, grass and hay) and potentially wood residue (e.g., wood chips) into ethanol, which is then blended with gasoline to produce a cleaner-burning fuel for vehicles.

In January 1999, the federal government announced plans to provide financial support for a community application to the United Nations that would see Clayoquot Sound—a 350 000-hectare area on the west coast of Vancouver Island, B.C.—designated as a "**biosphere site**." (The boundaries of the Long Beach Model Forest overlap the proposed Clayoquot Sound Biosphere Reserve.) The designation would provide greater opportunities for research and education, and it would highlight the work under way in Clayoquot in terms of sustainable economic development.

In March 1999, a **medium density fibreboard (MDF) pilot plant** began operation at Forintek Canada Corp.'s laboratory in Sainte-Foy, Quebec. This state-of-the-art facility, unique in North

America, will be used by industry and Forintek scientists to improve processing technologies, develop equipment, and design new value-added MDF products. The plant will test the impact of a wide variety of factors, for example, using different types of raw materials (i.e., agricultural waste, annual plants and urban residues); using new resins; and optimizing the manufacturing process to obtain the best panel properties, the lowest manufacturing costs and the least volatile organic emissions.

CANADA'S MILLENNIUM TREE

The millennium tree's roots can be traced back more than 30 years, to a magnificent white spruce growing near Lake Traverse in Algonquin Park, Ontario. Because of its stature and beauty, tree breeders from the Canadian Forest Service's Petawawa National Forestry Institute collected some cones and, in 1965, planted one of the seeds. After being relocated to the CFS's Valcartier Research Forest, the tree was rediscovered more than a decade later by researchers looking for trees to help improve Quebec's white spruce population. They chose this young tree for its superior height, straight trunk, and relatively small and uniform conical crown.

Grafts were taken and a controlled cross-breeding program began. The tree's offspring were greater in height with an above-average fibre length. With these superior qualities, it was deemed the ideal tree to mark Canada's millennium, and its seedlings are being planted all across Canada.

Hardy, handsome and useful, the white spruce flourishes everywhere in Canada, and adapts well to different soils and conditions. The millennium tree can live for 200 years or more, growing 25 m high and 4–8 m in diameter. The bluish-green needles are very aromatic. Its light, soft, moderately strong and low-resin wood has many uses, ranging from musical instruments to food containers, and from construction to pulp. Forest birds enjoy its seeds, and the millennium tree is a popular ornamental species.

The millennium tree was developed for Canadians by the CFS, as part of its pioneering work in tree genetics and improvement. The tree is a living national symbol that will flourish and grow with each year of the new century.

LATEST TRENDS

An overview of the **CHANGES** in Canada's forest sector

The family of 10 maple species is Canada's arboreal emblem.

CANADA

Population	30.3 million
Total area	997.0 million ha
Land area	921.5 million ha
Forest land	417.6 million ha
National parks	22.5 million ha
Provincial parks	22.9 million ha

FOREST RESOURCE

Ownership	
Provincial	71%
Federal	23%
Private	6%
Forest type	
Softwood	67%
Mixedwood	18%
Hardwood	15%
Annual allowable cut (1997)[a]	236.5 million m^3
Harvest (volume) – industrial roundwood (1997)[b]	182.7 million m^3
Harvest (area) (1997)	1.02 million ha
Status of harvested Crown land (1996)[c]	
Stocked (83%)	12.3 million ha
Understocked (17%)	2.5 million ha
Area defoliated by insects (1997)[d]	4.0 million ha
Area burned (1997)[e]	620 132 ha
Intensive Protection Zone burned	259 029 ha

FOREST INDUSTRY

Value of exports (1998)	$39.7 billion
Softwood lumber	28%
Other paper and paperboard	22%
Wood pulp	17%
Newsprint	17%
Waferboard	5%
Major export markets (1998)	
United States	79%
European Union	8%
Japan	7%
Others	6%
Balance of trade (1998)	$31.7 billion
Contribution to GDP (1998)	$18.2 billion
Value of shipments (1996)	$68.2 billion
Exported	56%
Sold domestically	44%
Number of establishments (1996)	13 473
Logging	9 605
Wood	3 162
Paper and allied	706
Employment (1998)[f] (1 job in 16)	877 000
Direct jobs	384 000
Indirect jobs	493 000
Wages and salaries (1996)	$11.2 billion
New investments (1997)	$7.1 billion

a, b, c, d, e, f *see page 33*

NEWFOUNDLAND AND LABRADOR

Black spruce
(Picea mariana)

Population	544 400
Total area	40.6 million ha
Land area	37.2 million ha
Forest land	22.5 million ha
Provincial parks	439 400 ha

FOREST RESOURCE

Ownership	
Provincial	99%
Private	1%
Forest type	
Softwood	91%
Mixedwood	8%
Hardwood	1%
Annual allowable cut (1997)[a]	2.6 million m^3
Harvest (volume) (1997)[b]	2.0 million m^3
Harvest (area) (1997)	20 000 ha
Status of harvested Crown land (1996)[c]	
Stocked (80%)	266 000 ha
Understocked (20%)	68 000 ha
Area defoliated by insects (1997)[d]	40 100 ha
Area burned (1997)	8 981 ha
Intensive Protection Zone burned	707 ha

FOREST INDUSTRY

Value of exports (1998)	$546.5 million
Newsprint	97%
Softwood lumber	3%
Major export markets (1998)	
United States	60%
European Union	22%
South and Central America	12%
Balance of trade (1998)	$535.5 million
Value of shipments (1996)	$744.0 million
Number of establishments (1996)	153
Logging	95
Wood	51
Paper and allied	7
Employment (1998)[f] (1 job in 27)	7 000
Direct jobs	5 000
Indirect jobs	2 000
Wages and salaries (1996)	$110.0 million
New investments (1997)	not available

PRINCE EDWARD ISLAND

Red oak
(Quercus rubra)

Population	136 388
Total area	0.57 million ha
Land area	0.57 million ha
Forest land	0.29 million ha
Provincial parks	1 500 ha

FOREST RESOURCE

Ownership	
Private	92%
Provincial	7%
Federal	1%
Forest type	
Softwood	35%
Mixedwood	35%
Hardwood	30%
Annual allowable cut (1997)[a]	0.5 million m^3
Harvest (volume) (1997)[b]	not available
Harvest (area) (1997)	not available
Status of harvested Crown land (1996)[c]	
Stocked (73%)	22 300 ha
Understocked (27%)	8 100 ha
Area defoliated by insects (1997)[d]	not available
Area burned (1997)	not available

FOREST INDUSTRY

Value of exports (1998)	$18.9 million
Softwood lumber	89%
Other paper and paperboard	9%
Major export markets (1998)	
United States	100%
Balance of trade (1998)	$18.2 million
Value of shipments (1996)	$28.0 million
Number of establishments (1996)	27
Logging	15
Wood	9
Paper and allied	3
Employment (1998)[f] (1 job in 53)	1 156
Direct jobs	831
Indirect jobs	325
Wages and salaries (1996)	$5.0 million
New investments (1997)	not available

NOVA SCOTIA

Red spruce
(Picea rubens)

Population	934 587
Total area	5.6 million ha
Land area	5.3 million ha
Forest land	3.9 million ha
Provincial parks	21 800 ha

FOREST RESOURCE

Ownership	
Private	69%
Provincial	28%
Federal	3%
Forest type	
Softwood	45%
Hardwood	33%
Mixedwood	22%
Annual allowable cut (1997)[a]	5.3 million m^3
Harvest (volume) (1997)[b]	6.6 million m^3
Harvest (area) (1997)	69 481 ha
Status of harvested Crown land (1996)[c]	
Stocked (96%)	176 000 ha
Understocked (4%)	6 500 ha
Area defoliated by insects (1997)[d]	not available
Area burned (1997)	564 ha
Intensive Protection Zone burned	564 ha

FOREST INDUSTRY

Value of exports (1998)	$789.6 million
Newsprint	40%
Wood pulp	24%
Softwood lumber	20%
Major export markets (1998)	
United States	59%
European Union	23%
Central and South America	11%
Balance of trade (1998)	$763.3 million
Value of shipments (1996)	$1.2 billion
Number of establishments (1996)	525
Logging	431
Wood	82
Paper and allied	12
Employment (1998)[f] (1 job in 19)	21 000
Direct jobs	14 000
Indirect jobs	7 000
Wages and salaries (1996)	$215.0 million
New investments (1997)	not available

NEW BRUNSWICK

Balsam fir
(Abies balsamea)

Population	752 999
Total area	7.3 million ha
Land area	7.2 million ha
Forest land	6.1 million ha
Provincial parks	24 900 ha

FOREST RESOURCE

Ownership	
Private	51%
Provincial	48%
Federal	1%
Forest type	
Softwood	47%
Mixedwood	29%
Hardwood	24%
Annual allowable cut (1997)[a]	11.1 million m^3
Harvest (volume) (1997)[b]	11.2 million m^3
Harvest (area) (1997)	112 436 ha
Status of harvested Crown land (1996)[c]	
Stocked (96%)	447 000 ha
Understocked (4%)	18 000 ha
Area defoliated by insects (1997)[d]	not available
Area burned (1997)	172 ha
Intensive Protection Zone burned	172 ha

FOREST INDUSTRY

Value of exports (1998)	$2.5 billion
Other paper and paperboard	32%
Softwood lumber	24%
Wood pulp	20%
Newsprint	15%
Major export markets (1998)	
United States	82%
European Union	7%
Japan	4%
Central and South America	4%
Balance of trade (1998)	$2.3 billion
Value of shipments (1996)	$3.6 billion
Number of establishments (1996)	911
Logging	743
Wood	146
Paper and allied	22
Employment (1998)[f] (1 job in 11)	29 000
Direct jobs	19 000
Indirect jobs	10 000
Wages and salaries (1996)	$498.0 million
New investments (1997)	not available

QUEBEC

Yellow birch
(Betula alleghaniensis Britton*)*

Population	7.3 million
Total area	154.1 million ha
Land area	135.7 million ha
Forest land	83.9 million ha
Provincial parks	7.1 million ha

FOREST RESOURCE

Ownership	
Provincial	89%
Private	11%
Forest type	
Softwood	58%
Mixedwood	23%
Hardwood	19%
Annual allowable cut (1997)[a]	58.8 million m^3
Harvest (volume) (1997)[b]	40.5 million m^3
Harvest (area) (1997)	363 844 ha
Status of harvested Crown land (1996)[c]	
Stocked (91%)	4.2 million ha
Understocked (9%)	425 000 ha
Area defoliated by insects (1997)[d]	17 000 ha
Area burned (1997)	393 078 ha
Intensive Protection Zone burned	93 753 ha

FOREST INDUSTRY

Value of exports (1998)	$10.8 billion
Newsprint	28%
Other paper and paperboard	28%
Softwood lumber	19%
Wood pulp	8%
Major export markets (1998)	
United States	87%
European Union	8%
Balance of trade (1998)	$9.3 billion
Value of shipments (1996)	$18.0 billion
Number of establishments (1996)	3 386
Logging	2 068
Wood	1 105
Paper and allied	213
Employment (1998)[f] (1 job in 17)	200 000
Direct jobs	115 000
Indirect jobs	85 000
Wages and salaries (1996)	$3.0 billion
New investments (1997)	$2.0 billion

ONTARIO

Eastern white pine
(Pinus strobus)

Population	11.4 million
Total area	106.9 million ha
Land area	89.1 million ha
Forest land	58.0 million ha
Provincial parks	6.3 million ha

FOREST RESOURCE

Ownership	
Provincial	88%
Private	11%
Federal	1%
Forest type	
Softwood	50%
Mixedwood	27%
Hardwood	23%
Annual allowable cut (1997)[a]	0.4 million ha
Harvest (volume) (1997)[b]	24.6 million m^3
Harvest (area) (1997)	197 941 ha
Status of harvested Crown land (1996)[c]	
Stocked (87%)	2.9 million ha
Understocked (13%)	487 000 ha
Area defoliated by insects (1997)[d]	5.4 million ha
Area burned (1997)	38 524 ha
Intensive Protection Zone burned	17 394 ha

FOREST INDUSTRY

Value of exports (1998)	$8.1 billion
Other paper and paperboard	37%
Newsprint	18%
Wood pulp	12%
Softwood lumber	11%
Major export markets (1998)	
United States	97%
Balance of trade (1998)	$3.4 billion
Value of shipments (1996)	$15.0 billion
Number of establishments (1996)	2 404
Logging	1 361
Wood	724
Paper and allied	319
Employment (1998)[f] (1 job in 32)	174 000
Direct jobs	96 000
Indirect jobs	78 000
Wages and salaries (1996)	$2.6 billion
New investments (1997)	$1.3 billion

MANITOBA

White spruce
(Picea glauca)

Population	1.1 million
Total area	65.0 million ha
Land area	54.8 million ha
Forest land	26.3 million ha
Provincial parks	1.5 million ha

FOREST RESOURCE

Ownership	
Provincial	94%
Private	5%
Federal	1%
Forest type	
Softwood	59%
Hardwood	21%
Mixedwood	20%
Annual allowable cut (1997)[a]	9.7 million m^3
Harvest (volume) (1997)[b]	2.1 million m^3
Harvest (area) (1997)	15 544 ha
Status of harvested Crown land (1996)[c]	
Stocked (94%)	232 000 ha
Understocked (6%)	15 600 ha
Area defoliated by insects (1997)[d]	125 949 ha
Area burned (1997)	41 796 ha
Intensive Protection Zone burned	11 042 ha

FOREST INDUSTRY

Value of exports (1998)	$479.9 million
Other paper and paperboard	27%
Newsprint	22%
Softwood lumber	18%
Waferboard	12%
Major export markets (1998)	
United States	94%
European Union	2%
Balance of trade (1998)	$192.8 million
Value of shipments (1996)	$873.0 million
Number of establishments (1996)	235
Logging	148
Wood	65
Paper and allied	22
Employment (1998)[f] (1 job in 41)	13 000
Direct jobs	9 000
Indirect jobs	4 000
Wages and salaries (1996)	$172.0 million
New investments (1997)	not available

SASKATCHEWAN

White birch
(Betula papyrifera)

Population	1.0 million
Total area	65.2 million ha
Land area	57.1 million ha
Forest land	28.8 million ha
Provincial parks	908 000 ha

FOREST RESOURCE

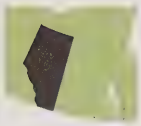
Ownership	
Provincial	97%
Federal	2%
Private	1%
Forest type	
Softwood	39%
Hardwood	36%
Mixedwood	25%
Annual allowable cut (1997)[a]	7.6 million m^3
Harvest (volume) (1997)[b]	4.1 million m^3
Harvest (area) (1997)	17 500 ha
Status of harvested Crown land (1996)[c]	
Understocked (66%)	263 000 ha
Stocked (34%)	135 000 ha
Area defoliated by insects (1997)[d]	150 436 ha
Area burned (1997)	3 885 ha
Intensive Protection Zone burned	2 265 ha

FOREST INDUSTRY

Value of exports (1998)	$673.0 million
Wood pulp	38%
Other paper and paperboard	28%
Softwood lumber	27%
Waferboard	6%
Major export markets (1998)	
United States	83%
European Union	9%
Japan	2%
Central and South America	2%
Balance of trade (1998)	$593.7 million
Value of shipments (1996)	$867.0 million
Number of establishments (1996)	249
Logging	189
Paper and allied	54
Wood	6
Employment (1998)[f] (1 job in 62)	8 000
Direct jobs	6 000
Indirect jobs	2 000
Wages and salaries (1996)	$149.0 million
New investments (1997)	not available

ALBERTA

Lodgepole pine
(Pinus contorta)



Population	2.9 million
Total area	66.1 million ha
Land area	64.4 million ha
Forest land	38.2 million ha
Provincial parks	1.3 million ha

FOREST RESOURCE

Ownership	
Provincial	87%
Federal	9%
Private	4%
Forest type	
Softwood	44%
Hardwood	33%
Mixedwood	23%
Annual allowable cut (1997)[a]	24.3 million m^3
Harvest (volume) (1997)[b]	22.2 million m^3
Harvest (area) (1997)	50 697 ha
Status of harvested Crown land (1996)[c]	
Stocked (66%)	557 000 ha
Understocked (34%)	286 000 ha
Area defoliated by insects (1997)[d]	195 059 ha
Area burned (1997)	4 725 ha
Intensive Protection Zone burned	4 725 ha

FOREST INDUSTRY

Value of exports (1998)	$2.6 billion
Wood pulp	46%
Softwood lumber	25%
Waferboard	14%
Newsprint	6%
Major export markets (1998)	
United States	71%
Japan	12%
European Union	8%
Balance of trade (1998)	$2.4 billion
Value of shipments (1996)	$4.2 billion
Number of establishments (1996)	642
Logging	401
Wood	212
Paper and allied	29
Employment (1998)[f] (1 job in 36)	42 000
Direct jobs	26 000
Indirect jobs	16 000
Wages and salaries (1996)	$622.0 million
New investments (1997)	not available

BRITISH COLUMBIA

Western red cedar
(Thuya plicata)

Population	4.0 million
Total area	94.8 million ha
Land area	93.0 million ha
Forest land	60.6 million ha
Provincial parks	8.3 million ha

FOREST RESOURCE

Ownership	
Provincial	95%
Private	4%
Federal	1%
Forest type	
Softwood	89%
Mixedwood	8%
Hardwood	3%
Annual allowable cut (1997)[a]	71.6 million m^3
Harvest (volume) (1997)[b]	69.3 million m^3
Harvest (area) (1997)	175 808 ha
Status of harvested Crown land (1996)[c]	
Stocked (76%)	2.8 million ha
Understocked (24%)	874 000 ha
Area defoliated by insects (1997)[d]	not available
Area burned (1997)	1 876 ha
Intensive Protection Zone burned	1 876 ha

FOREST INDUSTRY

Value of exports (1998)	$13.2 billion
Softwood lumber	49%
Wood pulp	21%
Other paper and paperboard	10%
Newsprint	6%
Major export markets (1998)	
United States	63%
Japan	17%
European Union	10%
Balance of trade (1998)	$12.1 billion
Value of shipments (1996)	$23.8 billion
Number of establishments (1996)	4 938
Logging	4 151
Wood	714
Paper and allied	73
Employment (1998)[f] (1 job in 11)	175 000
Direct jobs	97 000
Indirect jobs	78 000
Wages and salaries (1996)	$3.8 billion
New investments (1997)	$2.0 billion

YUKON TERRITORY

The Yukon Territory does not have an arboreal emblem.

Population	31 651
Total area	48.3 million ha
Land area	47.9 million ha
Forest land	27.5 million ha

FOREST RESOURCE

Ownership	
Federal	100%
Forest type	
Softwood	79%
Mixedwood	19%
Hardwood	2%
Annual allowable cut (1997)[a]	0.5 million m^3
Harvest (volume) (1997)[b]	not available
Harvest (area) (1997)	not available
Status of harvested Crown land (1996)[c]	
Understocked (76%)	7 000 ha
Stocked (24%)	2 200 ha
Area defoliated by insects (1997)[d]	not available
Area burned (1997)	not available

FOREST INDUSTRY

Value of exports (1998)	$1.7 million
Softwood lumber	86%
Major export markets (1998)	
United States	100%
Balance of trade (1998)	$1.4 million

NUNAVUT*

Nunavut does not have an arboreal emblem.

**created April 1, 1999*

Population	24 730
Total area	199.4 million ha

NORTHWEST TERRITORIES

Jack pine

(Pinus banksiana)

Population	67 468
Total area	342.6 million ha
Land area	329.3 million ha
Forest land	61.4 million ha

FOREST RESOURCE

Ownership	
Federal	100%
Forest type	
Mixedwood	58%
Softwood	33%
Hardwood	9%
Annual allowable cut (1997)[a]	236 500 m^3
Harvest (volume) (1997)[b]	not available
Harvest (area) (1997)	429 ha
Status of harvested Crown land (1993)[c]	
Understocked (85%)	2 600 ha
Stocked (15%)	440 ha
Area defoliated by insects (1997)[d]	487 556 ha
Area burned (1997)	126 531 ha
Intensive Protection Zone burned	126 531 ha

FOREST INDUSTRY

Value of exports (1998)	$5.7 million
Softwood lumber	93%
Major export markets (1998)	
United States	100%
Balance of trade (1998)	$5.6 million

NOTES

DATA SOURCES

The main sources for the data are Statistics Canada, Environment Canada, the Canadian Pulp and Paper Association, Natural Resources Canada–Canadian Forest Service and the National Forestry Database. Most of the information for the National Forestry Database was collected by provincial and territorial natural resource ministries. At the time of publication, all data were preliminary. As data are finalized, they will be made available on the Internet in the National Forestry Database (http://www.nrcan.gc.ca/cfs/proj/iepb/nfdp).

ARBOREAL EMBLEM

An illustration of the tree species that has been designated or officially adopted as the arboreal emblem of Canada and of each province and territory is included in the profiles on the preceding pages. The Yukon Territory and Nunavut do not have arboreal emblems.

FOREST LAND

The data regarding Canada's forest land are based on the Canada Forest Inventory (1994). The map on page 26 shows the forest land boundary.

FOREST RESOURCE

Ownership data are provided for the total forest land.

[a] Annual allowable cut: The level of harvest set by the provinces and territories for a certain length of time is called the "annual allowable cut" (AAC). AAC figures include data for both softwoods and hardwoods. The AAC figures for Newfoundland, Prince Edward Island, Nova Scotia, New Brunswick, Quebec and Manitoba include federal, provincial and private lands. Given the differences outlined below, a national AAC cannot be calculated by simply adding the provincial and territorial AACs.

- The national AAC figure that appears on page 26 was arrived at by estimating some data for private and federal lands, and converting the Ontario area figures into volume figures.
- Ontario provides figures for AAC (which it refers to as the "maximum allowable depletion") in hectares only.
- Saskatchewan, Alberta and Ontario do not include figures for private lands in their AACs.
- British Columbia does not include all private lands in its AAC.

[b] Harvesting: The national and provincial figures for harvesting volume include data for industrial roundwood only. The harvest level for fuelwood or firewood for a single province may range as high as 2.2 million m^3.

- Although the AAC for B.C. does not include all private lands, these lands are included in the harvest figure. The yearly harvest rate for B.C. may fluctuate, and in some cases, it may exceed the AAC. Over a five-year period, however, the harvest figure would be equal to or lower than the AAC.

[c] Status of harvested Crown land: These data reflect the cumulative area harvested since 1975. Data for private lands are not included. The term "stocked" refers to land where the forest cover meets certain timber-production standards established by forest management agencies in each province and territory. The term "understocked" refers to harvested land that requires forest management treatments, such as site preparation, planting, seeding or weeding, to meet established standards. This category also includes land that has not yet been surveyed. A significant proportion of recently harvested areas will always be reported as understocked because of the time lag between harvesting and observable results of subsequent treatments. The small percentage of the area harvested each year that is devoted to access roads is not included in these data.

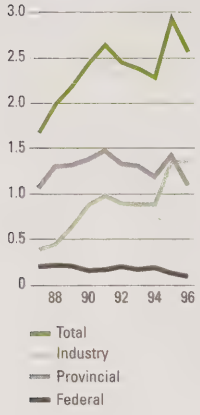
[d] Insect defoliation: The data relating to insects were provided by provincial and territorial agencies, and they include moderate-to-severe defoliation only. Defoliation does not always imply mortality; for example, stands with moderate defoliation often recover and may not lose much growth. Also, defoliation is mapped on an insect-by-insect basis, and a given area may be afflicted by more than one insect at a time. This may result in double or triple counting in areas affected by more than one insect, exaggerating the extent of the total area defoliated.

[e] Area burned does not include areas within national parks.

FOREST INDUSTRY

[f] Employment: The national employment figure includes both direct and indirect jobs in the forest sector. The total indirect jobs provided for each province will not add up to the national total, because the provincial figures do not include the indirect jobs created outside the province.

FOREST MANAGEMENT EXPENDITURES
$ billion



FOREST MANAGEMENT EXPENDITURES

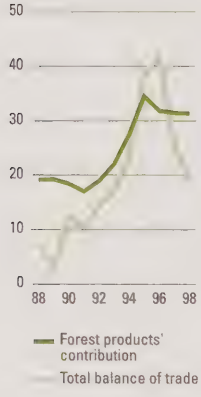
Forest management involves regenerating forest areas that have been harvested or damaged by fire or insects. Total forest management expenditures declined in 1996 from the previous year, due mainly to a significant drop in expenditures by the provinces. Federal government expenditures also declined, while expenditures by industry remained stable. In recent years, the provinces have shifted responsibility for forest management costs to industry. Between 1985 and 1996, industry expenditures more than tripled, while provincial expenditures rose before falling back to 1985 levels, and federal expenditures dropped by half. All told, forest management expenditures rose by more than 50% over the 11-year period, an average annual growth rate of 3.9%. During this period, cumulative spending on forest management totalled more than $26.2 billion.

1996*	$ BILLION	ANNUAL CHANGE	
		1-year	11-year
Total expenditures	2.6	-12.4%	+3.9%
Industry	1.4	0.0%	+11.7%
Provincial	1.1	-23.0%	+0.2%
Federal	0.1	-26.5%	-6.4%

**more recent data were not available at the time of printing*

Sources: Canadian Pulp & Paper Association; National Forestry Database

BALANCE OF TRADE
$ billion



BALANCE OF TRADE

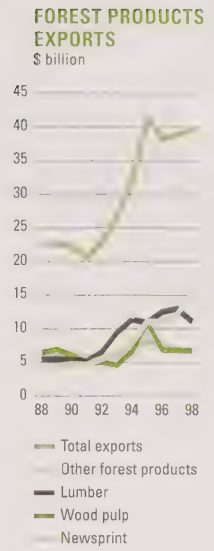
In 1998, forest products contributed $31.6 billion to Canada's balance of trade, nearly the same level as the previous year. For the eighth time in the past decade, Canada's balance of trade would have been in a deficit position were it not for the contribution of forest products exports. In 1998, Canadian exports of forest products went mainly to the United States (USA) ($31.3 billion), the European Union ($3.0 billion) and Japan ($2.7 billion). The increase in exports to the USA was partially offset by a drop in exports to the European Union and Japan. Canada imported $8.1 billion of forest products in 1998.

1998	$ BILLION	ANNUAL CHANGE	
		1-year	10-year
Forest products' contribution	31.6	-0.3%	+5.0%
Total balance of trade	19.6	-23.0%	+10.3%

Source: Statistics Canada

FOREST PRODUCTS EXPORTS

The total value of forest products exports rose by $800 million over the previous year's level to reach $39.7 billion in 1998, despite a decrease in the value of exports of traditional products (i.e., lumber, newsprint and wood pulp). Exports of other forest products posted a dramatic increase of nearly $3 billion, rising to $15.1 billion. Despite a slight increase in the quantity of lumber exported, lower lumber prices reduced the value of exports by 14.6%, to $11.1 billion. Exports of pulp and newsprint fell by approximately 1% in 1998. In the past decade, lumber exports have doubled, while those of other forest products have more than tripled. These results reflect the diversification of Canada's forest products exports. Exports of mechanical pulp papers, composite panels and prefabricated buildings are catching up with the traditional mainstay—commodity forest products. The principal market for Canada's forest products is the USA, which accounts for 79% of the total value of these exports.



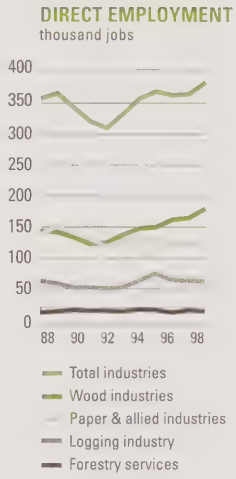
1998	$ BILLION	ANNUAL CHANGE 1-year	10-year
Total exports	39.7	+2.1%	+5.8%
Other forest products	15.1	+23.5%	+13.0%
Lumber	11.1	-14.6%	+7.5%
Wood pulp	6.8	-1.4%	+0.5%
Newsprint*	6.7	-1.0%	+0.8%

** includes some writing and other printing papers*

Source: Statistics Canada

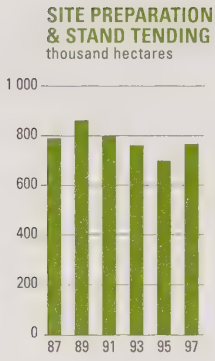
DIRECT EMPLOYMENT

The exceptional growth in U.S. residential construction continued to sustain the growth of Canada's wood industry. Despite the trade disputes with the USA over softwood lumber, the number of workers in this sector has increased for the seventh consecutive year since the 1991 recession, reaching a 10-year high. Employment in the paper and allied industries sector increased in 1998, recouping the jobs lost during the two previous years. This sector has not returned to pre-recession employment levels, however. Logging industry and forestry services employment levels tend to fluctuate from year to year; the losses in one year are often regained in the following year, with the result that the number of jobs in these sectors was the same in 1998 as it was 10 years ago. To summarize the past decade, employment gains in the wood industry more than offset job losses in the paper and allied industries, for a total increase of 26 000 jobs in the forest sector. (Direct and indirect employment in the forest sector accounted for 1 in every 16 jobs in Canada in 1998.)



1998	DIRECT JOBS	ANNUAL CHANGE 1-year	10-year
Total industries	384 000	+5.2%	+0.7%
Wood industries	180 000	+9.1%	+2.3%
Paper & allied industries	128 000	+4.9%	-0.8%
Logging industry	62 000	-1.6%	-0.2%
Forestry services	14 000	-12.5%	+1.5%

Source: Statistics Canada

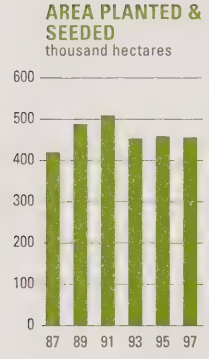


SITE PREPARATION AND STAND TENDING

"Site preparation and stand tending" refer to all silvicultural operations that improve the growth and quality of young trees—from thinning, fertilizing and pruning in recently planted forests, to commercial thinning in more mature forests. In the past 10 years, the area of site preparation and standing tending ranged from 700 000 to 863 000 hectares per year. Nineteen ninety-seven was an average year, with 768 326 hectares treated.

1997	HECTARES	ANNUAL CHANGE	
		1-year	10-year
Site preparation and stand tending	768 326	-0.1%	-0.3%

Source: National Forestry Database

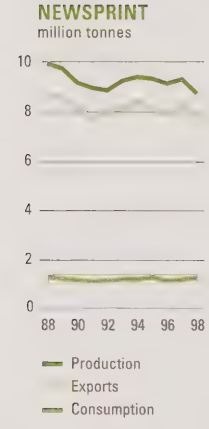


AREA PLANTED AND SEEDED

Planting and seeding programs are implemented at sites that have failed to regenerate several years after natural disturbances or harvesting. To date, such programs have been successful in reducing the backlog of understocked sites. In 1997, the area covered by planting and seeding programs was 458 638 hectares, up 1.9% from the previous year and slightly below the average of the past 10 years—470 000 hectares.

1997	HECTARES	ANNUAL CHANGE	
		1-year	10-year
Area planted and seeded	458 638	+1.9%	+0.9%

Source: National Forestry Database



NEWSPRINT

For Canadian newsprint producers, 1998 was a year they would rather forget, as export markets contracted sharply (86% of shipments go abroad and only 14% are consumed domestically). Canada's newsprint exports were down by 400 000 tonnes in Asia, 267 000 tonnes in the USA, and 123 000 tonnes in Latin America, for a total decline of 860 000 tonnes in 1998. There are probably many reasons for these decreases. The Asian economic crisis depressed newsprint demand; the entry of new producers undercut demand for Canadian products; and U.S. producers continued to boost their production, reducing U.S. import requirements. The decade is ending with the lowest level of production in the past 10 years, whereas 1988 saw the highest level recorded in history.

1998	MILLION TONNES	ANNUAL CHANGE	
		1-year	10-year
Production	8.6	-6.3%	-1.3%
Exports	7.4	-10.4%	-1.4%
Consumption	1.2	+5.7%	-0.1%

Sources: Canadian Pulp & Paper Association; Natural Resources Canada–Canadian Forest Service

LUMBER

In 1998, lumber production, exports and domestic consumption were virtually unchanged from 1997. Housing starts in Canada and the USA helped to maintain the previous year's record production level and even increase it slightly to 65.1 million m³. Falling prices resulted in lower business revenues, however. Exports and domestic consumption declined marginally, and imports were partly replaced by domestic production, resulting in a net increase in production. Over a 10-year period, exports have taken this industry to record levels, driven by the increasing demand of the U.S. market for lumber. Canadian domestic consumption, however, has remained below the levels of the late 1980s.

1998	MILLION m³	ANNUAL CHANGE	
		1-year	10-year
Production	65.1	+0.5%	+0.7%
Exports	48.4	-0.8%	+1.6%
Consumption	17.7	-0.9%	-1.7%

Source: Statistics Canada

WOOD PULP

Wood pulp producers did not enjoy a good year in 1998. Production, consumption and exports were down from the previous years' levels by 5.4%, 5.2% and 4.2%, respectively. Production in 1998 was 300 000 tonnes lower than 10 years earlier. In addition, the end use of production has changed. Just over 2 million tonnes of pulp are no longer processed into paper by Canadian producers, but are shipped abroad to be processed by other countries.

1998	MILLION TONNES	ANNUAL CHANGE	
		1-year	10-year
Production	23.5	-5.4%	-0.1%
Consumption	13.3	-5.2%	-1.5%
Exports	10.6	-4.2%	+2.3%

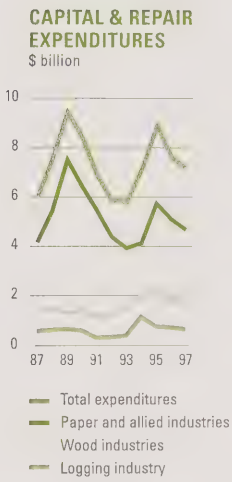
Sources: Statistics Canada; Natural Resources Canada–Canadian Forest Service

CAPITAL AND REPAIR EXPENDITURES

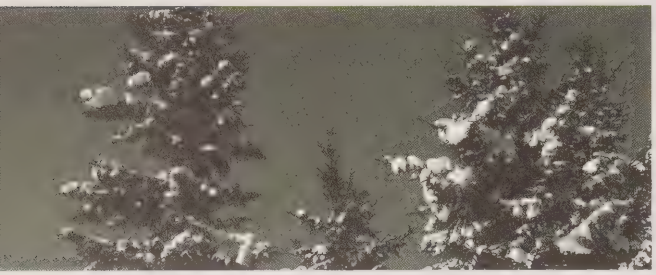
Capital and repair expenditures in the forest sector totalled $7.1 billion in 1997, down slightly from the past decade's annual average of $7.4 billion. In 1997, capital and repair expenditures in all forest industry sectors were down 6.6% from the previous year. The logging sector posted the largest decline, at 9.8%, followed closely by the paper and allied industries sector, which recorded a drop of 8.5%. The wood industry's expenditures declined by only 0.1%. The depressed prices for pulp and paper products and the resulting declines in profitability help explain the reluctance of paper mills to make new capital expenditures.

1997	$ BILLION	ANNUAL CHANGE	
		1-year	10-year
Total expenditures	7.1	-6.6%	+1.8%
Paper & allied industries	4.7	-8.5%	+1.2%
Wood industries	1.8	-0.1%	+4.1%
Logging industry	0.6	-9.8%	+1.2%

Source: Statistics Canada



CRITERIA AND INDICATORS: CANADA'S INITIATIVES



Criteria and indicators (C&I) play an important role in achieving the goals of sustainable forest management, and Canada is engaged in C&I initiatives at both the national and international levels.

DOMESTIC INITIATIVE

In 1993, the Canadian Council of Forest Ministers (CCFM) embarked on a domestic initiative to measure and report on forest values that Canadians consider important. In May 1995, after a year-long process of consultation, the CCFM adopted a framework of national C&I for sustainable forest management *(see below)*. The criteria represent forest values that Canadians want to sustain, while the indicators measure the criteria and track the nation's progress toward sustainable forest management.

In 1997, the CCFM described Canada's capacity to measure sustainable forest management in *Criteria and Indicators of Sustainable Forest Management in Canada, Technical Report* (http://www.nrcan.gc.ca/cfs/proj/ppiab/ci). This document led to a better understanding of Canada's strengths and weaknesses with respect to its capacity to measure forest sustainability.

CCFM CRITERIA AND INDICATORS FRAMEWORK

CONSERVATION OF BIOLOGICAL DIVERSITY	ECOSYSTEM CONDITION AND PRODUCTIVITY	SOIL AND WATER CONSERVATION	GLOBAL ECOLOGICAL CYCLES	MULTIPLE BENEFITS	SOCIETY'S RESPONSIBILITY
Ecosystem diversity	Disturbance and stress	Physical environmental factors	Global carbon budget	Productive capacity	Aboriginal and treaty rights
4 indicators	8 indicators	5 indicators	9 indicators	5 indicators	1 indicator
Species diversity	Ecosystem resilience	Policy and protection forest factors	Forest land conversion	Competitiveness	Participation by Aboriginal communities
3 indicators	2 indicators	3 indicators	2 indicators	3 indicators	5 indicators
Genetic diversity	Extant biomass		Carbon dioxide storage	Contribution to economy	Sustainability of forest communities
1 indicator	2 indicators		3 indicators	4 indicators	4 indicators
			Policy factors	Non-timber values	Fair and effective decision making
			5 indicators	4 indicators	3 indicators
6 CRITERIA			Hydrological cycles		Informed decision making
22 Elements			1 indicator		6 indicators
83 Indicators					

Subsequently, the CCFM agreed to report on Canada's progress toward sustainability in April 2000, at the United Nations Commission on Sustainable Development (UNCSD) in New York City. The Ministers also agreed to reevaluate the C&I framework to ensure that it reflects the current values and knowledge related to sustainable forest management.

INTERNATIONAL INITIATIVE

At the international level, Canada is participating in the Montréal Process—a working group of 12 countries that is developing and promoting a framework of C&I for temperate and boreal forests outside Europe. The *First Approximation Report of the Montréal Process*, published in 1997, provides an assessment of member countries' abilities to report on their progress toward sustainable forest management.

In October 1998, the Working Group agreed to prepare a report highlighting the innovative work being undertaken by Montréal Process countries to promote sustainable forest management and to implement, at the national level, internationally agreed-upon C&I. This report will be presented in 2000 at the eighth session of the UNCSD and at the twelfth Congress of the International Union of Forest Research Organizations.

In late 1999, the Montréal Process Working Group will meet to review its progress since the tenth meeting and to consider its next steps. Among other questions, the group will review papers produced by the Technical Advisory Committee on the following topics: the possible application of Montréal Process C&I to subnational levels, the issue of scale regarding the collection and aggregation of data at the national level, and the opportunities for further technical cooperation and information sharing among Montréal Process countries.

MONTRÉAL PROCESS CRITERIA for the Conservation and Sustainable Management of Temperate and Boreal Forests	No. of Indicators
1. Conservation of biological diversity	9
2. Maintenance of productive capacity of forest ecosystem	5
3. Maintenance of forest ecosystem health	3
4. Conservation and maintenance of soil and water resources	8
5. Maintenance of forest contribution to global carbon cycles	3
6. Maintenance and enhancement of long-term multiple socioeconomic benefits to meet the needs of society	19
7. Legal, institutional and economic framework for forest conservation and sustainable management	20

Further information on the Montréal Process is available on the Internet (http://www.mpci.org.)

CANADIAN FOREST SERVICE A CENTURY OF INNOVATIVE SOLUTIONS

This year, the Canadian Forest Service (CFS) celebrates 100 years of research and policy development devoted to the stewardship of Canada's forests, which feed our economy, clean our air and water, and define our nation.

It was more than a century ago that our fledgling nation, alarmed at the disappearance of the hardwood and pine forests of eastern Canada, began to see the effects of centuries of unregulated exploitation. In 1899, in response to the growing demands for conservation, the government of the day appointed Elihu Stewart as the first federal Chief Inspector of Timber and Forestry, and what has now become the CFS was born. Stewart condemned the excesses of the past and set the focus of the Dominion Forestry Branch on conservation and propagation, which translated into fire fighting, tree planting and the establishment of forest reserves.

By the 1920s, the Branch had helped bring forest science in Canada to new prominence. Staff members included graduates of the first university forestry programs, established more than a decade earlier with the support of federal foresters. The Forest Products Laboratories in Montréal, Quebec, and Vancouver, British Columbia—established by the Branch in 1913 and 1917, respectively—were dedicated to the study of commercial woods, their products and treatments. Investigations into ways of improving timber at its roots began in 1917, with the establishment of the Branch's Petawawa Forest Experiment Station, devoted entirely to silvicultural research. When the administration of natural resources was transferred to the prairie provinces in 1930, federal forestry put all of its resources into research, focusing on forest economics, silviculture, fire protection and forest products.

As concern about the timber supply escalated, federal forest science stepped up the search for innovative ways to sustain timber yields. The Forestry Branch got a short-lived but welcome boost in the 1960s, when it joined the forest biologists from the Department of Agriculture to form the first Department of Forestry. By 1966, this growing department was involved in international organizations, federal–provincial agreements, land inventories, soils research, forest measurement and surveys, forest fire control, and insect and forest products research. Much of this work continued, despite the loss of department status in 1969 and the series of funding and staff cutbacks that followed.

... our work ...
is only commencing ...

Since the early 1980s, when Canada began to lead the worldwide push for sustainable forest management, CFS science has been called on to help shape national and international forest policy (the reverse also is true), advance sustainable forest management, and increase the Canadian forest sector's competitiveness in the global marketplace. Today, through 10 national networks in 5 forestry centres across the country, CFS scientists are working in new areas of forest research, such as climate change, socioeconomics and biotechnology, and are bringing a new approach to perennial issues, such as fire and pest management.

As the principal federal forest research and policy coordination organization, the CFS plans to continue to help Canada follow through on its national and international commitments to sustainable forests. As a policy coordination agency, the CFS will continue to play a pivotal role in building consensus among Canadians to protect the economic, social and ecological benefits of our forests for present and future generations.

We must interest the nation, the individual,
the farmer, the settler, the lumberman, everybody
in the great work which is involved in forestry ...

—Sir Wilfrid Laurier, 1906

FEATURE ARTICLES

How Canada is adapting to evolving **FOREST VALUES** through **INNOVATION**

NEW DIRECTIONS FOR THE FOREST

Until the 1980s, Canada's forests were managed with timber as the overriding concern, as evidenced by the Dominion Forest Reserve motto of 1910: "Seek ye first the production of wood and its right use—and all these other things will be added unto it."

A new era of forestry in Canada began in the 1980s, when increased environmental awareness worldwide led to the 1987 Brundtland Report, which proposed the notion of sustainable development: meeting present needs without compromising the ability of future generations to meet their needs. "Sustainability" means taking a holistic look at forests—seeing beyond the trees, so to speak, to consider the central role of forests in Canada's environment, identity, heritage and economy.

WHAT IS DRIVING INNOVATION?

Putting environmental and social values on a par with economic concerns has no less than revolutionized forestry in Canada. At the same time, economic changes ranging from new competitors in the global market to the rising costs of harvesting less-accessible timber at home have meant that the forest sector must adapt to stay competitive. At all levels, forest management is no longer simply promoting timber production, nor is it just ensuring ecological sustainability; it is balancing a range of demands so that the nation's forests continue to satisfy all of our needs.

This kind of balance has not been reached quickly or easily. However, many Canadians with a stake in the environmental, social, cultural and economic health of our forests have taken advantage of opportunities to express their views. Their values now are reflected in the framework of criteria and indicators (C&I) for sustainable forest management in Canada *(see pages 38–39)*. Innovation—particularly through scientific and technical advances—is seen as one viable route to achieving that equilibrium.

Multiple Values

The late 20th century has been characterized by an increasing desire to protect the forest—its beauty, heritage value and recreational uses. More Canadians are voicing the personal values they attach to the forest. Some see forests as places of scenic beauty and spiritual reflection. Others prize them as destinations for hiking, camping, hunting and other recreational pursuits. Many, including Aboriginal peoples, value forests for their historical or traditional significance.

Conventional definitions of the forest's economic value also have been changing. Non-consumptive uses of forest land make up a larger part of the forest economy. Increasingly, people are earning income from alternative forest resources, such as tourism and recreation. Vacation packages, outdoor outfitting, camping, and guided hunting and fishing expeditions are multiplying. As well, worldwide interest in ecotourism is focusing new attention on Canada's forests as ecological destinations. Forest incomes are also earned from the sale of maple products, wild berries and mushrooms, Christmas trees, essential oils, ornamental boughs and greenery, craft products and medicinal products.

Remaining Competitive

The traditional forest industry remains a cornerstone of the economy and way of life in Canada. As the country's leading manufacturing sector, the forest industry employs 1 in every 16 Canadians and supports hundreds of communities from coast to coast. Our forests are also vital to the global wood supply, and Canada is the world's largest exporter of forest products. However, because it exports some 60% of its output, the Canadian forest industry is greatly dependent on access to international markets. In recent years, concerns about competition, market access and the resource itself have led the industry to reevaluate the way it does business.

The Canadian industry is facing stiff competition from timber-rich Eastern Europe. It is also competing with burgeoning wood-producing nations in the Southern Hemisphere that, with their temperate climates and accelerated growth rates, are harvesting from managed tree plantations at a low cost. In addition, Sweden and Finland, two of Canada's traditional competitors, have rates of timber growth that are twice that of Canada.

The effects of increased competition abroad are being magnified by changes at home. The Canadian forest industry's traditional competitive advantage—an abundant supply of low-cost, easily accessible, high-quality timber—is diminishing. Partly as a result of legislation protecting more of the forest, the country's most accessible timber is now in shorter supply.

Producers are being forced to turn toward more distant stands, which are often lower in quality and more expensive to develop and harvest. As well, technological advances, especially in pulping and composite wood products, have allowed lower quality fibre to replace some applications for Canada's fibre.

The forest products market itself also is changing. Advances in construction methods, engineered wood products and communications technology have altered consumer demand for Canada's traditional wood and paper commodities; instead, customers are seeking specialized products to meet specific and rapidly changing needs. Furthermore, the industry has had to grapple with numerous issues affecting international market access, including trade tariffs, export quotas, foreign policies on recycled content, international building codes and standards, and the move toward certification of forest products originating from sustainably managed forests.

SHAPING INNOVATION

Canadian governments own 94% of Canada's forests. As such, the policies and legislation of both levels of government—federal and provincial/territorial—have far-reaching effects on forest management and are largely shaping the way the sector pursues innovation.

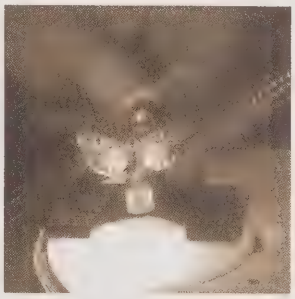
Recent forest policies and legislation have been responding to environmental, social and economic concerns. Provinces/territories have brought in legislation and forest practice regulations that protect the health of their forests by, for example, requiring forest companies to consult with the public before making harvesting decisions, and prohibiting the spraying of synthetic pesticides that may be considered harmful to the environment. From a national perspective, federal and provincial/territorial governments and non-government organizations alike have developed and adopted a National Forest Strategy that is a collective statement of intention toward forest management that makes economic, environmental and social sense. The Canadian framework of C&I for sustainable forest management has been developed and adopted by many of these same stakeholders as a way of tracking the sector's progress toward sustainable forest management. Canada is also working toward an international convention on forests that would more clearly define stewardship of international forests *(see page 95)*. As well, governments are responding to economic challenges, in large part by determining the development of forest science and technology (S&T).

Faced with changing economics, markets and public values, the forest industry has been issued a sobering challenge: adapt or decline. For the forest industry, the solutions to staying competitive and to addressing social values and environmental concerns have been the same—innovation, preferably developed at home.

As economic globalization is showing signs of challenging Canada's seat as the world's leading exporter of timber and wood products, many believe the industry's ability to compete in the global marketplace will increasingly depend on how quickly it can develop and apply new knowledge. Because other forest producers can avail themselves of cheaper labour, faster regeneration times or advances that increase productivity, Canada's forest industries will become increasingly dependent on the strength of their ability to lead by innovation. The sector's competitive edge may, in fact, soon be almost entirely dependent on S&T advances and the speed with which these advances can be applied in the field. Technological innovation is helping the sector develop and protect the forest resource, adjust forest management planning and operations, revamp production processes, increase

fibre recovery, develop new value-added and specialty products, and tap new markets.

But the technological revolution has done more than enhance productivity. It has also injected new life into the sector's quest for environmental sustainability. As myriad forces have compelled Canada's forest industries to find more environmentally responsible ways of doing business, the sector has availed itself of recent advances in biotechnology, information science and chemical engineering, and it has invested in the development of new machines and new ways of using knowledge. The industry's investment in research, development and public consultation has paid off in an array of innovations—new technologies, tools and forest management methods. Not only are these innovations mitigating the sector's impact on the environment, but they are also helping ensure that forest managers have the data they need to manage Canada's forests sustainably and that purchasers of Canadian wood products have the information they need to be responsible consumers.



Innovations driven by environmental, social and economic concerns are showing that balancing different approaches to forestry may not be as difficult as it once seemed. Already, research and development (R&D) that seeks to improve the productivity in Canada's forest industries is also benefiting the sector's environmental performance, and technologies developed to solve environmental problems are proving more operationally sound than their conventional counterparts. As environmental sustainability becomes a prerequisite for economic viability, the S&T that is fueling improvements on both fronts will benefit from increasing synergy. For example, genetically engineered super trees, bred for faster growth or disease resistance, have the potential to reduce or eliminate the need for pesticides.

National Strategies

The provinces are constitutionally responsible for 71% of Canada's forests; however, the federal government plays a lead role in representing Canada on the world stage and in bringing stakeholders together from across the country to develop national strategies. Since the 1980s, the federal government has spearheaded a partnership approach to developing a series of forward-looking policies and agreements that address both national and international commitments to sustainable forest management. The most recent example is a road map for forest management in the next century.

Canada's National Forest Strategy (1998–2003) is a multi-contributor document that presents nine strategic directions that address the interconnectedness of ecological, economic, social and cultural aspects of the forest. It also sets out specific commitments to forest management that recognize and respect this delicate balance. The Strategy is voluntary rather than regulatory in intent, presenting common forest objectives agreed to by the diverse signatories to Canada's Forest Accord, and allowing the forest community to decide exactly how to meet those objectives.

ON THE WORLD STAGE

Canada's National Forest Strategy and the earlier strategies that led to it have set an example for other forest nations. With the release of its initial comprehensive five-year strategy in 1992, Canada became the first country to commit to sustainable forest management on a national level. The 1992 strategy also put Canada in the spotlight at that year's "Earth Summit"—the United Nations Conference on the Environment and Development (UNCED)—and reinforced Canada's leadership in sustainable management.

ENVIRONMENTAL ECONOMICS

Growing worldwide attention to sustainable management and increased emphasis on non-timber benefits (e.g., recreation, wildlife, tourism, aesthetics and heritage values) have made it increasingly impossible to consider economic influences on the forest industry without considering broader societal influences. In the forest products market, public values and expectations are key determinants, particularly now that the public has a greater say in how forests are developed and managed, and how or if they are harvested. Forest product certification is one of the many issues confronting the forest industry in which there is a clear intersection between market forces and changing public values regarding forests.

The UNCED process, and the international commitments that stemmed from it, led Canada to develop another area of innovative national forest policy: national, science-based C&I to guide and measure sustainable forest management *(see pages 38–39)*.

TRADE AND SUSTAINABLE FORESTS

Canada is also working to have a clearer picture of sustainable forest management in the international forest community. As quickly as traditional tariffs and quotas on forest products are dismantled, non-tariff barriers take their place. The federal government closely monitors potential trade barriers and uses scientific evidence to challenge those that are discriminatory. Recently, Canada intervened successfully against the European Commission's proposal for mandatory labeling of timber products; it was also successful in reversing a motion by the City Council of Los Angeles, California, that would have tied government purchasing to a particular forest certification standard.

Many countries are demanding that imports come from sustainably managed forests, but there is no international agreement defining "sustainable forest management." Without such an agreement, the World Trade Organization must settle disputes over non-tariff barriers.

In June 1997, after failing to reach consensus on the need for an international convention on sustainable forests at a Special Session of the United Nations General Assembly, a majority of countries expressed the need for more discussion. Recently, Canada teamed up with Costa Rica to organize these discussions and thus contribute to the work of the Intergovernmental Forum on Forests *(see page 95)*.

Provincial Forest Policies

The federal government represents Canada internationally and coordinates the building of national consensus to balance Canadian forest values; however, the provinces are ultimately accountable for most of Canada's forests, and their policies comprise the substance of forest management in this country. *(A comprehensive overview of public forest management policy was provided in* The State of Canada's Forests 1997–1998.)

Provincial governments have had to respond to the growing expectations of Canadians for their forests. The provinces have shifted their philosophies at the policy level and have widened their objectives to encompass multiple forest values: setting aside more Crown land for non-industry use; adjusting annual allowable cuts; and in their Crown tenure systems, requiring more comprehensive and stringent planning and operational procedures that address non-timber values.

In early 1998, Alberta released a forest strategy after extended public consultation. The Alberta Forest Legacy is an innovative policy that clearly

states the wide-ranging economic, social and ecological goals that Albertans have for their forests. In fact, the Forest Legacy builds these goals into its definition of "sustainability," which it describes as "the state in which we can be confident that the forest resource and all its values will be available to us not just today, but also tomorrow." The Forest Legacy takes the innovative approach of "adaptive management," which means that the government's forest management objectives and methods will change as society, the economy and forest ecosystems evolve.

Saskatchewan's Forest Resources Management Act and its new regulations, which came into effect in April 1999, are another example of how public concerns and values are driving today's forest policy. The regulations were finalized after two years of consultation. Invitations to participate were issued to everyone who helped develop the Act, and to representatives of the forest industry, communities and First Nations. Under the Act, public consultation is mandatory at all levels of planning, and forest companies must demonstrate that they have consulted First Nations and the public, must regularly monitor and report on their forest operations (with involvement from communities and interest groups), and must have their forestry management plans audited every five years.

Forest Management: Beyond Legislation

Most of Canada's leading forest companies harvest timber from a mixture of Crown (government owned) and private (freehold) forests, with the Crown harvest generally outweighing that of the freehold. When operating on Crown land, forest companies are governed by the terms and conditions of forest tenure agreements. Throughout the 1990s, these terms and conditions have become more all-encompassing, in line with evolving provincial forest policies and societal expectations. Accordingly, forest companies have had to alter the way they manage and operate on Crown land, such as setting aside more tenured land for recreation or conservation, or modifying harvesting in certain areas to respect wildlife habitat or traditional hunting grounds.

ONTARIO'S LIVING LEGACY

Ontario announced some very significant land-use planning decisions and allocations on March 29, 1999, entitled "Ontario's Living Legacy." The announcements were the result of a Lands for Life initiative and included the biggest increase in history in Ontario's system of parks and protected areas. They also included measures to enhance outdoor recreation and to improve the business climate for northern communities, the forest industry, and resource-based tourism and mining industries. The Living Legacy initiative applies to millions of hectares of forested lands and of lakes, rivers and streams across a planning area that runs from just north of Peterborough to the 51st parallel. It includes nine signature sites—special areas identified for a broad range of outdoor activities and international marketing purposes.

Highlights:

- **378 new parks, new protected areas and additions**
- **2.4 million hectares in new protected areas**
- **more than 9.5 million hectares in total protected areas**

For the forest industry, as for the federal and provincial/territorial governments, public values and public involvement are transforming forest planning and management. As interest groups, local residents and First Nations grow more knowledgeable about forest management issues and articulate their expectations, they are demanding much greater involvement in local decision making. In some provinces, such as New Brunswick, British Columbia (B.C.) and Saskatchewan, forest companies are required by legislation and tenure agreements to involve the public in forest management planning. In provinces where public consultation is not mandatory, most companies are choosing to involve the public in planning decisions because it makes it easier to balance timber and non-timber concerns.

When forest companies operate on their own private land, they are technically free from the restrictions of Crown tenure agreements and from many of the provincial regulations and codes that govern their operations on public forest land. Despite this freedom, industrial forest owners manage their private forests in much the same way as their Crown allotments. All of Canada's major industrial forest owners have long-term sustainable management plans for their private forests—plans that account not only for sustained timber yield, but also for non-timber values, such as biodiversity and aesthetics. Most companies operating on both private and public lands simply extend the Crown management requirements to their private holdings, although some administer separate plans for their private forests. Either way, the industry's inclusion of non-timber values in managing private forests is a sure sign that public values are influencing corporate decision making.

COMMUNITY INVOLVEMENT

The forest industry's approach to forest use and management is perhaps best illustrated by the many companies that actively encourage multiple uses of their forest land. Here again, it is revealing to look at what companies are doing in their freehold forests.

In Canada, virtually all major forest companies use their land for more than just timber production. The vast majority of companies allow the public to travel on their logging roads; to hunt and fish in their forests; and to use their land for recreational activities, such as hiking, cycling, camping, skiing and snowmobiling. Some forest companies even maintain parks and trails solely for recreational use. More and more, companies are opening up their forests for educational purposes, offering nature trails, interpretive centres, working nurseries, and forestry-related exhibits and demonstrations. As well, many have set aside conservation areas, heritage sites and other special places within their boundaries.

Planning was crucial for MacMillan Bloedel Ltd., for example, when it decided to harvest some of its forest land just north of Vancouver, B.C. Community residents were using the 48-hectare site for hiking, biking and horseback riding, and many of them were worried that harvesting would scar the landscape and affect the water quality.

After listening to residents' concerns at public meetings and considering the goals of the official community plan, MacMillan Bloedel and the independent contractor hired to do the harvesting came up with a plan that would accommodate recreational, aesthetic and environmental objectives while keeping the operation profitable. Throughout the harvesting, the contractor stayed in close touch with the community, making it easy

to agree on details and consider new ideas as the project progressed.

The result is an attractive commercially thinned forest, with rights-of-way and roads that are narrow, curving and well-camouflaged, thanks to small and versatile harvesting machinery. A special drainage system that takes advantage of the site's naturally quick-draining soil means there are no unsightly ditches and no problems with water quality. Today, more local residents than ever before are using the site for recreation.

Another example of community involvement in forestry-related decision making is B.C.'s Community Forest Pilot Project, which is giving the public a chance to take their interest in the forest one step further. Community forests have been established as a new Crown tenure category in the province, and communities and First Nations can apply to manage a local forest area under tenure agreement. Overall, the Community Forest Pilot Project aims to strengthen the role of communities and First Nations in forest management, and to test ways in which these groups can manage forests for a range of objectives, both timber and non-timber.

NEW DIRECTIONS FOR PRIVATE WOODLOTS

Private woodlot owners have always associated their forests with many values and uses. For as long as individuals have owned forested land in Canada, they have derived different benefits and pleasures from that land—some related to the owners' sustenance or livelihood (e.g., hunting, fishing, trapping, logging and maple syrup production), some related to settlement (e.g., harvesting for building materials, fence logs and firewood), and some related to the forest's spiritual or aesthetic appeal.

Although woodlot owners and the associations affiliated with them have varying opinions about how private woodlots should be managed—especially about whether management should be regulated—most agree in principle that it is important for forest owners, as stewards of an important resource, to use and harvest their lands sustainably. With forest sustainability in Canada no longer just a conceptual goal but a measurable commitment, private woodlot management is an issue that is gaining national attention.

Other groups of private landowners also are working toward responsible self-management. In Ontario, for example, the Private Land Resource Stewardship Program represents landowners and interest groups concerned about the management of private lands. The 40 volunteer stewardship councils across the province identify environmental priorities for their regions, and carry out projects ranging from workshops on woodlot management to stream restoration and tree planting. The initiatives sponsored by woodlot associations and other groups are all voluntary; the onus is on the woodlot owner to participate in forest management and education.

In several provinces, the tide has begun to shift in the past year toward more government involvement in private woodlots. In some instances, governments and woodlot owners are taking an approach that is based not on restrictive legislation, but on new models, incentives and consultations.

On the east coast, for example, New Brunswick woodlot owners have had a voluntary code of practice in place for several years. Developed by the New Brunswick Federation of Woodlot Owners, the code promotes economically and environmentally sustainable operations in private forests within a framework of individual objectives. In February 1999, the New Brunswick government introduced measures to further

encourage private forest management, including a new property tax rebate that woodlot owners can claim each year if they operate their woodlots under a forest management plan. In addition, the Province will monitor private timber harvesting more closely to better determine harvest levels and will introduce voluntary licensing, certification and registration of private contractors operating on private woodlots.

In Prince Edward Island, where 92% of the forest is privately owned, the government is discussing the recently drafted Forest Contractors Code of Practice Regulations. The draft regulations require forest contractors to register with the Department of Agriculture and Forestry and to adhere to certain standards: harvesting in ways that protect the long-term health and productivity of the landowner's forest, meeting adjacent landowners' needs, protecting streams and ponds, and preventing excessive rutting or soil damage.

LOWER ST. LAWRENCE MODEL FOREST

Covering three wooded areas in the Lower St. Lawrence region of Quebec, two owned by the forest industry and one composed of 1 500 private woodlots, this model forest is experimenting with sustainable management practices under a project aptly titled "Une forêt habitée." The Lower St. Lawrence Model Forest is indeed inhabited: it is a living, producing and settled forest that is rich in timber, wildlife, heritage sites and botanical products. The partners hope to manage the Model Forest to keep both the rural economy and the forest ecosystems healthy.

The Model Forest is managed using two innovative systems: tenant management and group management. The tenant management model, adapted from traditional tenant farming, is being tested in the two areas owned by Abitibi Consolidated Inc. Tenants have been allocated 23 forest parcels averaging 1 000 hectares each; in return, tenants agree to manage the forest productively and in accordance with the Model Forest's multi-resource management plan. Tenants are individually responsible for whatever logging, silviculture, wildlife development or other operations they decide to carry out on their land. But they work together in cooperatives to oversee shared resources, such as hunting, fishing, tourism and recreational activities, all of which supplement the tenants' income from timber harvesting.

The group management model is being applied to the third area of the Model Forest. Known as the "Est du lac Témiscouata" territory, the area comprises 6 municipalities and 700 woodlot owners. One of the principal partners in the Model Forest, the Groupement forestier de l'Est du lac Témiscouata, is responsible for overseeing and managing forestry activities in the territory. Although forest groups like this one have operated in Quebec since the 1970s, they have traditionally focused on timber production. The Groupement forestier in the Lower St. Lawrence Model Forest is taking a broader view, extending its activities to cover the management and use of all resources in the forest. For instance, in 1994, the Groupement forestier launched an extensive project in water-course management, which included enhancing fish habitat and spawning grounds and developing hiking trails and fishing sites. The group is also looking at alternative forest products, such as maple syrup and maple-based alcoholic beverages, forest ginseng, medicinal plants and wild mushrooms, that could add to the woodlot owners' income from logging and silvicultural activities. In addition, the Groupement forestier and woodlot owners are studying hunting, fishing, trapping and ecotourism opportunities for the area. Some woodlot owners have already started up small outfitting companies specializing in such activities as guided bear hunts and the hunting of stocked game birds.

INNOVATIVE FOREST PARTNERSHIPS

Canadian forest policy and management models have been moving in new directions at the national, provincial, industry and private woodlot levels. But some of the most innovative approaches to forest policy and management are coming from new forest partnerships that cross the boundaries between these jurisdictions and involve representatives from all of them.

The Canadian Model Forest Network, consisting of 11 model forests that represent the chief forest regions of Canada, may be the country's best-known and most emulated system of forest partnerships. *(See page 50 for a closer look at one of these partnerships.)* Formed to explore ways of balancing the current demands on Canada's forests with the needs of future generations, the model forests are working demonstrations of how diverse forest values can be integrated into a single managed area. Each model forest is run cooperatively by partners representing communities, industry, labour, governments, woodlot owners, First Nations, universities, R&D organizations, environmental groups and other interested parties. Serving as full-scale, on-the-ground laboratories for researching and testing ground-breaking forest management practices, the model forests are leading the way in developing balanced, region-specific approaches to forest management. They are also setting an example for international model forests, which continue to look to Canada for leadership.

Another novel partnership, Canada's First Nation Forestry Program, has been increasing Aboriginal participation in the forest sector since 1996. Involving First Nations, Natural Resources Canada, and Indian and Northern Affairs Canada, the Program aims to create forestry jobs for Aboriginal people, stimulate profitable forest businesses and joint ventures, and encourage First Nations to sustainably manage on-reserve forests.

Linking Environmental and Economic Concerns: A New Forest Science

More than ever, the forest community is looking to forest S&T for the knowledge and innovation needed to adjust to demands for both sustainability and profitability. S&T can increase the forest sector's competitiveness, not only by providing new products and more productive ways of doing business, but also by countering non-tariff barriers and thereby ensuring access to international markets. In addition, S&T is coming up with a host of environmentally responsible forest practices, such as ecologically sound pesticides and lower-impact harvesting practices. Research is also looking beyond timber to the socioeconomic implications of forest practices. Additional examples of how S&T is contributing to more innovative approaches to forestry are provided in "Leading by Innovation: Forest Science and Technology."

S&T IN CANADA

In the past five years, there has been reduced funding for forest research at both the federal and provincial government levels. Coincidentally, as governments have been shifting more research responsibilities onto industry, the forest sector has been responding to a tougher economic climate by pulling out of research programs and closing their research centres. Canada has the most lucrative tax credit system in the world for R&D (so generous that it has attracted the attention of the Organization for Economic Cooperation and Development [OECD]); however, the forest sector has generally been opting to buy new technologies rather than invest in its own research programs. Currently, more than 50% of the machinery and equipment used in the forest products industry in Canada is imported.

In 1997, the Canadian Council of Forest Ministers (CCFM) organized a national forum of S&T leaders to develop a course of action to

address forest sector S&T needs. Upon tabling the *National Forest Science and Technology Course of Action* in 1998, it was recognized that real progress depended on a national communication and coordination mechanism to make the document vibrant and relevant. That recognition led to the establishment of FORCAST—a private, non-profit coalition established to provide the direction and infrastructure necessary to ensure that S&T are aligned with national priorities. FORCAST members will collectively shape S&T management in Canada.

Over the years, Canada's forest sector has allowed reductions to occur in its investment in forest research, frequently opting to purchase the fruits of research conducted abroad. In 1996, Canada's total investment in forest research was 0.36% of the value of the forest products shipped, compared with 1.5% in the United States and 1.75% in Sweden.

THE MAIN PLAYERS

In Canada, S&T in the forest sector is carried out somewhat differently than in other industries. Although some major forest companies conduct proprietary research and create technologies, applications or products, most firms contribute to technological development by funding one of the three industry research institutes (also funded by provincial and federal governments).

FERIC, the Forest Engineering Research Institute of Canada, is a private and non-profit institute widely acknowledged as a world leader in forestry operations research. FERIC concentrates on wood harvesting, the processing and transportation of forest products, silvicultural operations and small-scale forestry operations. FERIC has roughly 100 projects active across Canada at any given time, each run by a team that is drawn from a pool of scientists and researchers, industry representatives, government partners, universities, technology firms, equipment manufacturers and forest contractors.

Forintek Canada Corp., a non-profit corporation that operates under a federal charter, is dedicated to research for the solid wood products industry. It focuses on four research areas: manufacturing technology, market support research, forest resource characterization, and technology transfer and technical services to its industry and government members. Forintek's overall aim is to help the industry take advantage of market opportunities created by technological innovation. This goal has placed it at the forefront of worldwide technological development in such areas as wood drying and protection; lumber, veneer and composite board manufacturing; and the safety of building systems.

Paprican, the Pulp and Paper Research Institute of Canada, is a non-profit research and educational organization committed to enhancing the technical competitiveness of its member companies. Considered a world leader in pulp and paper research, Paprican focuses on pulp and paper technology needs and environmental technology development. It conducts research in four areas: fibre and product quality, pulping processes, paper and board manufacturing, and closed-system mill technologies.

Forest research and technological development are carried out by many other organizations and partnerships in Canada. At the federal level, Natural Resources Canada–Canadian Forest Service is the largest research body, with five forestry centres across the country. Other federal departments and agencies also participate in forest research, either individually (e.g., Environment Canada, Agriculture and Agri-food Canada, and the National Research Council) or in partnership (e.g., through the Networks of Centres of Excellence program). Provincial governments and agencies play a significant role as well, particularly on the applied side.

Academia also is a large contributor. Eight Canadian universities house forestry faculties, and many post-secondary institutions are pursuing forest-related research through other disciplines, including biology, engineering, chemistry and computer science.

SOCIOECONOMICS: BEYOND THE TREES

Scientists are still in the early stages of quantifying, studying and integrating diverse forest values, but some ground-breaking research is under way.

At the forefront of research into socioeconomic forest values is the Sustainable Forest Management (SFM) Network, one of Canada's Networks of Centres of Excellence. The SFM Network's overall mandate is "to develop strategies that align economic and environmental objectives to ensure that Canada's boreal forest is effectively managed, that its biological diversity [is] preserved, and that its resources [are] sustained for future generations." Socioeconomic sustainability is one of the research themes of the SFM Network. The socioeconomic program draws on the work of economists, anthropologists, sociologists, political scientists, health specialists and geographers, and it involves the cooperation of industry, government, First Nations and other research institutes. The group's social and economic studies will lead to the creation a multivalent framework within which other researchers can develop improved environmental technologies for forest management.

Another multidisciplinary project—one that is capturing international attention—is the Canadian Forest Service's socioeconomic program. (Members of this group collaborate with members of the SFM group.) This leading-edge program was established to tackle the question of quantifying non-timber values. An international team of economists, social scientists and psychologists is devising methods for measuring the worth of such non-economic values as hunting, fishing, camping, canoeing, and protecting wildlife and biodiversity. Using a method called "choice experiments," the researchers are studying how people make trade-offs between economic and biophysical forest attributes. The team is also looking at the social and economic significance of forest activities and disturbances, such as timber harvesting, pesticide application, forest fires and climate change. The result will be a measurement system that forest managers can use to factor non-timber values into forest management plans in an objective, tangible way.

Researchers are also applying science to another intangible forest value—visual aesthetics. People often cite how greatly they value the appearance of forests, leading many forest managers near populated areas to account for aesthetics in their site plans and operations. But researchers are taking aesthetics a step further. In eastern Canada, a team from industry and government is evaluating a landscape approach to forest management in which an entire forest area is divided into design units and managed accordingly. The landscape management approach incorporates not only visual aesthetics, but also biodiversity and other ecological values. Under this approach, forest planners collect input from those who live near and use the forest—recreational clubs, First Nations, hunters and local residents—before drafting the forest design. Then, once the design is completed, it is approved by these stakeholders before being applied to the forest.

The landscape management approach is also being tested by several forest companies in the Maritimes. The companies have found the design approach easy to apply and have concluded that it does not diminish the wood supply. Managing forests by design unit may well prove to be a systematic and environmentally sound way of ensuring that forests retain their visual appeal.

Government policy and changing approaches to management can only go so far in easing the difficult transitions facing the Canadian forest sector. Governments, industry and environmental groups are all looking to forest S&T to help sustain the economic, environmental and social benefits of our forests.

The idea that technological innovation can solve problems is no more of a new concept than environmentalism, social responsibility, or the forest sector's need for economic stability. And as important as they are, new technologies will not be the sole determinants of the forest sector's—and Canada's—successful transition to a new kind of forest stewardship. Much of the innovation of the next century, like that of the past decade, will come simply from thinking outside the box.

Examples of innovation within Canada's forest sector, both from the technological and policy perspectives, are provided throughout the following article.

LEADING BY INNOVATION:
FOREST SCIENCE AND TECHNOLOGY

According to a 1997 survey by Natural Resources Canada, a mere 51% of Canadians think of the forest industry as being "high-tech." Although this number is up from 45% in 1993, it still means that nearly half of all Canadians see the forest sector as having somehow eluded the wide reach of technology. Yet nothing could be further from the truth. As myriad forces have compelled Canada's forest industries to find more environmentally friendly and economically viable ways of doing business, the sector has availed itself of recent advances in biotechnology, information science and chemical engineering, and has invested in the development of new machines and new ways of using knowledge. Some advances address economic concerns, others address environmental standards, and many do both. In this article we showcase some of the innovations that have been driven by the evolution of forest values as described in the previous article.

FOREST PLANNING AND MANAGEMENT—SEEING THE WHOLE

Forest planners and managers need concrete ways of incorporating environmental and other non-timber values into their decision making. They also need the reductions in costs and the increases in productivity that result from innovative approaches to such activities as surveying and doing inventories. As evidenced in the following text, Canadian scientists have been developing numerous technologically sophisticated systems and tools that do both.

Trees and Satellites

Remote sensing—scanning the Earth's surface by satellites or high-flying aircraft to gather detailed information about the planet—is making labour-intensive and time-consuming inventories a thing of the past.

Canadians have developed a cost-effective combination of computer software and airborne remote-sensing technology that produces far more detailed and meaningful pictures of forest composition. An advantage of this new system is that a computer, not a person, analyzes the digital pictures taken by remote sensing and does so in great detail. By interpreting information about the shadows between trees and the light reflected by different tree leaves, the computer system can detect individual tree crowns and tree species—a big improvement over previous remote-sensing systems, which only permitted stand-based inventories. The new system can also automatically group trees according to their species and other salient characteristics, enabling forest managers to compile faster and more accurate inventories, to pinpoint areas that are ready to harvest, and to detect areas that need protection or help in regenerating.

Global positioning systems (GPS) technology originated outside the forest sector, but is highly suited to simplifying large-scale forest surveying and mapping—tasks that once required large expenditures of time and resources. GPS applications for the forest sector are considered to be in their infancy, although Canadian researchers have made a lot of headway. There are certain obstacles to overcome, such as the sheer complexity of the technology, which requires advanced expertise to operate, and the tendency of trees to interfere with GPS signals.

The integration of GPS units with special sensors on forest machinery to record and geo-reference all activities performed by the machine is nearing reality. Development of the technologies is well under way and will streamline forest management tremendously. For instance, these integrated systems will be able to record the exact location of equipment breakdowns, enabling forest managers to assess machinery performance on specific sites. As well, these technologies will enable the recording of individual felled trees, which will lead to faster and more precise inventory updates.

Decision Support

Computer software that predicts the outcome of management decisions is becoming indispensable to multi-resource managers.

One such decision-support system that is winning positive reviews is Interface, developed by the Forest Engineering Research Institute of Canada (FERIC). Interface simulates specific harvesting and regeneration decisions to determine their impact on other phases of forest management. Users can also test the effects of particular harvesting decisions on regeneration, and they can experiment with different approaches to find one that fits specific operating conditions. Although the software is intended principally for on-site forest analysts, FERIC is also using the application for in-house research to evaluate how new designs and equipment might affect on-site costs and productivity.

INTEGRATING WILDLIFE AND ECOSYSTEM VALUES INTO FOREST MANAGEMENT

Researchers and foresters are using more sophisticated analytical tools to manage the forest for both timber and non-timber attributes.

In the boreal plains of northwestern Alberta, for example, industry and government are collaborating on a 20-year series of harvests and surveys to determine the optimal balance between timber harvesting and the long-term sustainability of the boreal ecosystem. The project involves testing a variety of harvesting systems to achieve the best integrated use of the boreal mixedwood landscape.

A similar project has been undertaken near Thunder Bay, Ontario, to build a strong ecological foundation for integrated resource management in boreal mixedwoods. Two forest companies are working with scientists from the Ontario Ministry of Natural Resources and Natural Resources Canada–Canadian Forest Service (CFS) to study the structure of boreal mixedwoods at the stand and watershed level and to determine the response of these stands to disturbance and manipulation. In the Black Sturgeon Boreal Mixedwood Research Project, researchers are examining the interactions of various harvesting regimes, prescribed fires and mechanical site preparation techniques to determine the long-term ecological impact of these activities on forest renewal and aquatic ecosystems.

Another ecosystem-based approach to forest management that is generating interest makes use of information on how forests respond to natural disturbances, such as wildfires and insect infestations. The idea is to preserve ecosystem integrity by ensuring that vital organisms and soil conditions are retained or quickly reestablished after harvesting and that wildlife habitat is preserved. Using a model designed by scientists at the University of Alberta and the CFS, Daishowa-Marubeni International Ltd. and Canadian Forest Products Ltd. are piloting a 1 000-hectare study in northern Alberta that is expected to provide a century's worth of information on how forests can be managed to emulate natural disturbances.

For another example of related experiments, please see page 58.

Another Canadian-designed software tool enables forest managers to establish the location of harvestable timber and tells them whether the timber is located in an ecologically sensitive area. Collaborators on the National Geo-referenced Information for Decision-makers (NATGRID) project are refining a computer-based decision-support tool that can superimpose numerous layers of precise digital information regarding an area's topography, soil conditions, temperature, precipitation, forest type and proximity to roads. The increasing availability of such advanced landscape-modeling techniques enables forest managers to better assess the trade-offs between timber production and potential environmental impacts as they integrate environmental values into decisions regarding forest management and harvesting.

Predicting Productivity

The traditional way of calculating the potential productivity of a forest stand—the site index—cannot be used to determine the contribution of variables (e.g., climate, fire and insect epidemics) to the site's productivity (the rate at which wood of given specifications is produced). Recognizing that today's forest planners need more detailed information on productivity, especially to make informed decisions regarding sustainable management and the effects of climate change, Canadian scientists are devising a better tool—known as "ECOLEAP" (Extended COncertation for Linking Ecophysiology and forest Productivity)—for measuring present and potential site-level productivity. The ECOLEAP project team is developing models of the tree

INNOVATIONS IN HARVESTING—M.A.S.S.

In Canada, the pressure to find alternatives to clearcutting, especially in old-growth forests, has been building for some time and originates from many sources. As society's interest in multiple forest values mounts, and the pressure for green certification of forest practices increases, forest managers in British Columbia's (B.C.'s) old-growth forests need to know where alternatives to clearcutting are most feasible, economical and ecologically sound.

The Montane Alternative Silvicultural Systems (M.A.S.S.) project was established in 1992 to study these issues. (M.A.S.S. is located on the private land of MacMillan Bloedel Ltd., south of Campbell River, B.C.) It is the first major interdisciplinary study on the implications of partial-cut harvesting in old-growth temperate rainforests in the coastal montane region. The relative merits and drawbacks of three partial-cutting silvicultural systems are being compared to the established practice of clearcutting.

TEST PLOTS HARVESTED

Test plots were harvested in 1993: one 69-hectare area was clearcut; and nine 1-hectare areas were harvested, each with a different partial-cutting treatment. Trees were felled manually, and differing amounts of trees were left standing, ranging from 50% on the patch cut to 30% on the shelterwood cut and 5% on the green tree cut. A 20-hectare area was left uncut to provide an undisturbed baseline-monitoring reserve.

HARVESTING FEASIBILITY AND COSTS STUDIED

In the early stages of the project, M.A.S.S. researchers studied the harvesting operations to see how feasible they were and to determine what they would cost. Harvesting costs were higher for the partial cuts than for the clearcut: 49% higher for the shelterwood cut and 12% higher for each of the other two cuts. In the future, with the green tree cut, now known as the "retention system," the remaining trees will be left in clumps to improve harvesting efficiency and reduce costs.

IMPACTS ON FUTURE FORESTS EXAMINED

Currently, scientists are studying the biological and silvicultural impacts of the partial-cut harvesting methods. For example, researchers are looking at what impact these harvesting methods will have on the next generation of forest. The intention in all three partial-cutting treatments is to leave behind a representative sample of the stand profile and, through time, to grow younger trees under and between groups of residual trees that could be harvested later on. Soil disturbance and productivity, regeneration, seedling responses to competition and nutrition, bird and insect diversity, and the genetic consequences of alternative silvicultural systems are some of the aspects being investigated.

Researchers are also studying how these partial-cutting methods affect the big remaining trees in the harvested area. For example, researchers have been documenting wind damage on the trees left standing. Some of the trees have been unable to withstand winter winds and have fallen over, which raises questions about the long-term viability of partial-cutting systems.

THE BOTTOM LINE

The M.A.S.S. project has already contributed to the knowledge and realization that forestry can be done differently on the coast. (In June 1998, MacMillan Bloedel announced its intention to adopt the green tree retention system for the majority of its harvesting in coastal B.C. and to retain 10%–20% of the trees in clumps where feasible.) Many of the studies will be monitored for at least 20 years to provide more definitive answers on the implications of alternative silvicultural systems on montane ecosystems in coastal B.C.

growth process to better understand the mechanisms that control forest productivity. The team is also investigating practical methods and tools for applying this information at the stand, landscape and regional levels, which may enable forest managers to predict productivity on a larger scale. In addition, the ECOLEAP team is now examining how remote sensing technology can facilitate these large-scale productivity measurements.

SPRUCE BUDWORM DECISION-SUPPORT SYSTEM

CFS researchers are working on a computer-based "what if" system to help forest managers make the best of a bad situation: contending with the next spruce budworm outbreak, due in 5–10 years. Some of the trade-offs that forest managers will have to make include whether to accept timber losses, to harvest in advance or salvage harvest the dead trees, or to prevent widespread tree mortality by aerially spraying the budworms with the biological insecticide *Bacillus thuringiensis (B.t.)* or other environmentally acceptable materials. Each decision leads to more detailed considerations that need to be assessed.

The CFS's Spruce Budworm Decision-Support System (DSS) forecasts various budworm outbreak and forest protection scenarios so that managers can determine priorities and wood supply benefits, and can visualize the impact of their decisions. It is the first system to link forest protection and forest management in such a functional way. The Spruce Budworm DSS is being implemented in partnership with the forest industry and provincial governments in all of the forests in New Brunswick and on test sites in Quebec, Ontario and Alberta.

FOREST PROTECTION

Each year in Canada, losses from insects, diseases and fire are greater than the total area of forest harvested. Although governments have introduced legislation that restricts the spraying of synthetic pesticides in forests, the need to protect the timber supply for its economic value has increased and has spurred the development of environmentally sound control alternatives. In fact, Canada has emerged as a world leader in the development of these alternatives.

Taking their cue from nature, Canadian researchers have been successful in developing new insect pathogens using the forest's own defences—viruses, bacteria, fungi and naturally occurring chemicals. Advances in information technology have powered the development of computer-based modeling techniques that help foresters decide when and where these new pesticides will bring the best results.

Closing in on the Target

Advances in molecular biology have made possible the isolation and genetic manipulation of viruses that are specific to such pests as the spruce budworm, redheaded pine sawfly, Douglas-fir tussock moth, gypsy moth and European pine sawfly—all of which can pose threats to some of Canada's most valued commercial tree species and thus its overall timber supply.

Insect viruses are ideal pest control agents. They are extremely target-specific, having very little impact on anything other than the insect for which they are intended. Also, there is much less chance of insects building immunity to viruses, as sometimes happens with synthetic insecticides. Moreover, because they are highly contagious—even a dead insect can be a carrier—viruses can be applied in smaller doses than their conventional counterparts. And lastly, viruses have more staying power: a virus can remain effective for a few years after being sprayed, whereas many other control agents must be reapplied regularly.

Although insect viruses are attractive alternatives to synthetic pesticides, some (e.g., the

CARBON CYCLE MODELING

Canada has an international commitment to do its part in the quest to understand the role of forests in climate change. It is well known that forests are an important part of the natural carbon cycle, but the forest's exact role in the carbon cycle, and therefore its role in climate change, have traditionally been little understood.

The CFS has been studying the forest carbon cycle and its relation to climate change for almost a decade. The result is the Carbon Budget Model, the first model in the world for assessing national carbon budgets. Researchers are currently testing the model to determine how management activities, such as harvest schedules, reforestation and forest protection, affect the forest's contribution to the carbon cycle. The results to date suggest that forest management may be a significant element in controlling the effects of climate change.

Canada's Carbon Budget Model is an important step toward understanding and influencing the global carbon budget. It is also a concrete example of how forest science in Canada, and indeed throughout the world, is evolving to keep up with the research challenges presented by new and shifting forest values.

spruce budworm virus) were found to be too slow acting to be really effective. Several superior spruce budworm viruses have since been engineered by replacing non-essential genes in the virus with genes taken from the spruce budworm. (Because the new genes originate from the host insect, no foreign genes are introduced into the ecosystem.)

Acting on Instinct

Some naturally occurring substances influence the behaviour and development of insects rather than killing them outright. These chemicals are both target-specific and environmentally benign.

One group of these substances, sex pheromones, has received special attention. Working with Simon Fraser University, Natural Resources Canada–Canadian Forest Service (CFS) has determined the composition of the pheromones emitted by female spruce budworms, forest tent caterpillars, Douglas-fir tussock moths and white-marked tussock moths to attract males for mating. Such discoveries have important implications.

Pheromones can be used in traps to monitor insect populations, providing a warning of outbreaks and making it possible to pinpoint the most infested areas. This information enables forest managers to use a minimal amount of pesticide and to apply it only where needed. As well, the information on insect populations can be used to judge the effectiveness of spray programs.

Pheromones can also control insect outbreaks. Releasing artificial pheromones into the atmosphere causes male insects to become disoriented, preventing mating. The problem has been to find a way to imitate nature by slowly releasing the pheromones into the atmosphere during the breeding cycle. In response to this challenge, Canadian scientists are developing a microencapsulation technique—somewhat like a time-release capsule—to release the pheromones at a controlled rate over a long period.

Naturally occurring chemicals can also be used to derail a target insect's vital internal processes, again without affecting the surrounding community. Canadian researchers are involved on many fronts in the development, testing and registration of such pest control alternatives. For example, one product—Mimic®—induces premature molting in the spruce budworm and jack pine budworm. Recently registered for aerial application in forests in Canada, this compound triggers the molting process and, with it, certain changes in the larva that render it incapable of eating—the insect starves to death.

FUTURA®: CFS DEVELOPS A BIOLOGICAL INSECTICIDE

During an insect infestation, the larvae of the spruce budworm moth can devour millions of hectares of forest. Feasting on spruce, balsam fir and Douglas-fir, these pests can strip a tree of its new shoots in three weeks. After several years of severe defoliation, a forest will not recover. The trees that the spruce budworm does not kill, it weakens, leaving them vulnerable to other diseases and pests. For these reasons, Canada has been, and continues to be, involved in efforts to protect its forests from these pests.

Chemical spraying of the forest was a common control method until the mid-1980s; however, research into an environmentally safe alternative to synthetic chemical sprays started more than two decades earlier. In 1960, Canada began testing *Bacillus thuringiensis (B.t.)* to see whether it could adequately protect trees from the spruce budworm. (*B.t.* had already been registered for agricultural use in the United States (USA), but it had never been tested for forestry use.) Since the 1960s, CFS scientists have made numerous contributions to the operational use of *B.t.* as a biological insecticide in forestry, including the development of their own marketable *B.t.* product, Futura®.

THE EARLY STEPS

B.t. is a naturally occurring soil bacterium that can be sprayed on fir and spruce trees. When spruce budworm larvae feed on the sprayed needles, the lining in their gut is destroyed, and the larvae die within days. That is the theory. In practice, it took some 25 years of intensive testing and refining to develop Futura® as a serviceable product.

In the very first lab tests, *B.t.* barely affected the spruce budworm larvae. That is to say, after ingesting the bacteria, most larvae survived. However, further research found that if the intestinal wall (covered in a teflon-like surface) could be pierced, the bacteria could go to work. Before long, researchers hit upon an enzyme called "chitinase." When spruce budworm larvae were placed in the *Bacillus*–chitinase combination, they dropped like flies.

FROM THE LAB TO THE AIRPLANE

Success in a petri dish is one thing, but success in the field can be another matter. However, the aerial spraying trials were promising, and research continued. The aerial spraying initially occurred over several hundred acres of infested forest and was followed by sprayings over larger areas. At that point, scientists began to concentrate on developing a formula for *B.t.* that would be efficient and economical—a viable alternative to synthetic chemical sprays. Producing a more concentrated formula was a sure way to reduce the volume sprayed and, consequently, the treatment cost.

A STICKY BREAKTHROUGH

To obtain a totally safe formula, CFS researchers eventually struck upon sorbitol, a corn syrup, as an additive. This natural product offered solutions to several problems. For example, researchers were looking for a way to reduce evaporation during spraying, especially when large, fast and high-flying aircraft were used for the operation. Sorbitol worked. Researchers also found that sorbitol protected their formula from contamination and spore fermentation. (In fact, sorbitol keeps Futura® intact for years.)

In 1984, the super-concentrated *B.t.* formula called "Futura®" was registered. Today, this product is used throughout Canada and abroad to control not only spruce budworm, but also gypsy moth and tent caterpillar.

Bioherbicides: A Gentler Solution

Insects are not the only foes to succumb to advances in molecular biology. Environmental legislation that restricts the use of herbicides in riparian zones (forested strips along waterways) and the high cost of manual brushing (generally $600–$800 per hectare compared with $400 per hectare for biological control agents) have created a strong incentive to develop alternatives to synthetic herbicides.

Biological control agents offer realistic and natural solutions to vegetation management problems—the upshot being healthier young forests and increased fibre production with less environmental impact. Much of the work in this area involves taking naturally occurring microorganisms and adapting them so that they can be used inexpensively against target species that compete with valuable seedlings. The aim is not to introduce new enemies, but rather to increase the incidence of naturally occurring ones to epidemic proportions, giving the seedlings a head start.

Canadian-developed ECO-clear® is the first biocontrol agent for use in integrated vegetation management in Canada. ECO-clear® is a fungus that suppresses the resprouting of red alder trees and other invasive hardwoods that tend to proliferate in cleared areas, hindering the establishment of commercially preferred seedlings.

Canadian researchers have also discovered that another naturally occurring fungus—*Fusarium avenaceum*—attacks weeds, such as thimbleberry, salmonberry and wild red raspberry, that sprout prolifically in reforested areas and kill more young conifers than any other brush species. Researchers have found that when the fungus is brought to epidemic levels, it kills the weed species without affecting the surrounding conifer seedlings. The fungus then reverts to normal levels as the weeds die out. A commercial formulation of this biocontrol will be available early in the new millennium.

PHEROMONE TRAPS

In 1985, CFS researchers invented a portable moth trap that has had a major impact on researchers' ability to monitor and study some of Canada's most damaging forest pests. In essence, the Multipher™ has turned out to be an early warning system for insect population trends. (The Multipher™ contains a synthetic version of female sex pheromones that lure male moths into the trap.) Analysis of data from this trap over several years gives researchers roughly five years' advance notice of insect outbreaks.

In 1992, CFS researchers invented a second moth trap, the Lumonic™, which contains pheromones and a small light that attract male and female moths into the trap.

Bluejoint grass is another aggressive competitor; it chokes out slower growing tree seedlings on approximately one-quarter of the reforested mixedwood boreal stands in western Canada. Synthetic herbicides control the grass, but they are not ecosystem sound and can kill the seedlings unless they are applied within a narrow window of time. Canadian research has found that snow mould, a native fungus, can be used to stunt the growth of the grass long enough for the seedlings to gain a foothold. CFS researchers are also developing combinations of fungi and bacteria that will attack the grass on two fronts.

Forest Fire Management

Each year in Canada, forest fires claim roughly as many hectares as the annual harvest, making fire management a top priority for forest health and productivity.

The CFS recently completed a groundbreaking study on the behaviour of crown fires (hugely destructive fires in which flames spread quickly across tree tops, consuming vast areas in a short time). Each year, crown fires are responsible for a large proportion of the forests lost to fire

BEST FIRE-MONITORING SYSTEM IN THE WORLD

In Canada, some 10 000 wildfires burn roughly 2.5 million hectares of forests each year, at a cost of roughly half a billion dollars in fire suppression alone. Fortunately, Canada's fire management system has revolutionized our ability to quickly detect and combat fires.

75 YEARS OF FIRE SCIENCE

The fire management system developed by Canadian scientists represents the culmination of 75 years of fire science. It includes computer programs that can help fire managers evaluate the risks and spread of forest fires, and can offer managers efficient ways of fighting fires, right down to the number of water bombers needed and where to position initial-attack crews.

In the 1980s, the CFS Forest Fire Danger Rating System gained international recognition when it was adapted for use in New Zealand and Alaska. More recently, the Canadian Wildland Fire Information System (CWFIS) has been adapted for use in B.C., Alberta, Saskatchewan, South East Asia, Florida and Mexico, with other provinces and countries giving it close consideration.

It is the next generation of fire detection and computer mapping, however, that promises efficiency at a grand scale. Referred to as the "Fire M3 project," it features technology that uses satellites to track and map forest fires.

SATELLITE MAPPING IS MORE ACCURATE

The Fire M3 project is a joint venture involving two Natural Resources Canada operations—the CFS and the Canada Centre for Remote Sensing (CCRS)—that was initiated to develop a fully automated national system to monitor, map and model forest fires daily. It integrates the CFS's fire management systems with the CCRS's satellite monitoring and mapping technologies.

The project, which was launched in 1995, is attracting international attention as the best fire-monitoring system in the world. The new technology is fully automated and provides more uniform, objective information than the older technology, which relies on traditional mapping techniques, such as aircraft surveillance, aerial sketch mapping and global positioning systems (GPS) mapping. Another bonus of the new system is the big financial savings.

MORE TIMELY INFORMATION AVAILABLE

A third advantage of the new technology is that it gathers fire information daily and converts it into meaningful data, often within 12 hours. (The older technologies can take up to a week to process similar information.) As a result, fire agencies can receive timely, detailed information. The public benefits as well—people using the Internet can zero in daily on fire activity maps that contain the latest information. This is particularly useful for people in remote areas. By seeing the overall fire hazards in their area, locals will have a better understanding of which fires pose real threats.

Much of the information this new technology provides is available for the first time. For example, by adding certain variables to the daily fire activity maps, scientists can now calculate daily fire intensity and other fire-behaviour indices. Other variables, such as daily fuel consumption, can be calculated and combined to automatically detect smoke and distinguish it from cloud cover.

The Fire M3 technology has international applications as well. Scientists can, for the first time, calculate daily smoke emissions from every fire in Canada to support global change modeling and reporting.

worldwide. The study, which resulted in a detailed, field-tested physical model of crown fires, provides information on how these fires start and spread. This crown fire model, along with the fire monitoring systems described on page 63, has established Canada as the world's leading innovator in advanced forest fire management.

CANADIAN WATERBOMBERS

In the 1960s, Canadian engineers designed the world's first true waterbomber, the Canadair CL-215. These aircraft, built by Canadair Ltd., were designed specifically to fight forest fires. The waterbomber's main feature is its efficient water-scooping capability. The aircraft's boat-like hull enables the plane to skim across a lake or river and scoop up more than 5 000 L of water. In calm or rough water, the planes can scoop water and douse fires repeatedly for up to four hours.

In 1994, Canadair designed a successor to the CL-215 waterbomber—the CL-415. The CL-415 is the most advanced fire fighting aircraft in the world, featuring a four-compartment, four-door water tank system that can load 6 137 litres of a water–foam mixture. This redesigned aircraft offers superior low-speed handling, and it is ideal for repeatedly dropping large amounts of fire-suppressing foam and controlling a fire at the earliest stages.

BIOTECHNOLOGY: BUILDING A BETTER TREE

Canada has been leading research into forest genetics for decades now, and it has become clear that advanced genetic research translates into large economic and environmental pay-offs in the forest. Advances in biotechnology and genetics are yielding ways to boost the hardiness and productivity of our trees—an issue of mounting interest to an industry that needs to get the most from a less-accessible forest resource—as well as decrease need for the use of synthetic pesticides. And trees that produce more fibre and are more resistant to insect pests and diseases will take some of the pressure off natural forests as sources of fibre. Much of the work in Canada focuses on spruces and pines—two commercially important tree species nation-wide.

THWARTING THIEVES

CFS work on wood DNA-analysis techniques may lead to a forensic spin-off: catching and thwarting tree thieves. As CFS scientists refine methods of identifying tree DNA, it may be possible to match a specific yellow or western red cedar log with its stump and to determine whether the log was harvested without authorization. Trees, like all living organisms, contain DNA—genetic material in cells that is as individual as a set of fingerprints. Currently, $10 million–$20 million per year is lost to tree rustlers in B.C.

(In June 1999, Dr. Eleanor White, a research scientist with the CFS, received the Public Service Excellence Award for her pioneering work in applying DNA fingerprinting to help combat tree theft.)

Canadian researchers have spent years developing advanced tree breeding techniques and genetically superior stock, resulting in sophisticated and practical systems for improving the growth and hardiness of seedlings. For instance, the results to date for an ongoing white spruce breeding program suggest that the genetic height gain in 15-year-old trees is 15%–25%. In 45-year-old trees, the estimated volume gain over naturally regenerated trees can be as much as 50%.

Canadian research scientists are also taking a new direction these days with their investigations into innovative DNA-based approaches to silviculture. One initiative is concentrating on isolating genetic markers for characteristics that are economically important, such as wood density and fibre length; current studies are focusing on commercially valuable white spruce. There is also ongoing work to identify genes associated with such traits as cold tolerance, sterility, and resistance to pests and pathogens. Once identified,

NEW TECHNIQUE WILL REVOLUTIONIZE HOW WE REPRODUCE TREES

In Canada, our knowledge and skills base in a new cloning process are setting the stage for a dramatic change in how we propagate our commercially important trees. The new process, referred to as "somatic embryogenesis," involves cloning conifer trees using tissue culture.

ACCELERATED TREE BREEDING

In the natural world, a germinated white spruce seed takes between 15 and 20 years to mature into a tree capable of producing seeds. If that original seed grows into a tree of superior quality, its offspring contain only half that superior gene pool.

Somatic embryogenesis, on the other hand, offers enhanced quantity and quality. Using somatic embryogenesis, in a matter of months, researchers can fast-track a single seed into an unlimited number of seedlings ready for planting. And by selecting a genetically superior tree to clone, scientists can produce seeds that contain 100% of that superior gene pool.

CFS BREAKTHROUGHS

The CFS is recognized as a pioneer and world leader in somatic embryogenesis. Its first breakthrough in this area occurred in the mid-1980s with larch. A few years later, the CFS cracked the code for cloning spruce and eastern white pine embryos in tissue culture. Recently, CFS scientists have made similar advances with western white pine and jack pine.

In any event, there is no universal recipe for somatic embryogenesis. With every tree species that scientists attempt to clone, they have to adapt the tissue culture process.

FROM THE PETRI DISH TO THE GREENHOUSE

Somatic embryogenesis involves cutting out the embryo from the seed and growing it under suitable conditions in petri dishes. Creating that suitable environment involves finding the right culture medium, the proper lighting and humidity conditions, the correct gelling agents, and so on. After the embryo has reproduced prolifically, clumps of the embryonic tissue are transferred to a new medium where they mature into regular-looking embryos. These embryos are then transferred to another medium to germinate. When they have developed roots, shoots and primary needles, these somatic seedlings are transferred to soil and acclimatized in a greenhouse.

PRESERVING THE GENETIC MATERIAL

While these early stages of tree growth have been accelerated, the seedlings still take years to grow. That means researchers must wait years before they can confirm whether they have chosen the best embryos. Fortunately, embryos can be frozen for easy, long-term storage through a process called "cryopreservation." As a result, the frozen embryos can be retrieved years later and be successfully propagated after field testing has shown which clones are the best performers.

BENEFITS DOWN THE ROAD

Currently, a B.C. company is producing and selling white spruce somatic seedlings. The possibility of producing and selling genetically superior somatic seedlings for Canada's other commercial species offers an exciting prospect that would dramatically change how these trees are propagated.

these genes could eventually be introduced into species to improve their hardiness and overall productivity. Genes for cold tolerance in white pine and for resistance to white pine blister rust have already been isolated. The first Canadian field trial of genetically engineered trees has been launched, enabling the tracking of poplar trees that have been modified with marker genes.

Boosting Immunity

Canadian researchers have also come up with a way to "inject" spruce trees with the gene that encodes the development of the bacteria *Bacillus thuringiensis (B.t.)* so that the trees themselves can produce the toxin. Several new transgenic (genetically altered) plants engineered for insect resistance using the *B.t.* toxin were commercialized in 1998. As well as reducing synthetic pesticide use, transgenic trees may also cut the time needed to reestablish a forest and its wildlife because fewer trees will be lost to insects and diseases during regeneration.

Researchers have also found an antimicrobial gene that resists white pine blister rust and have modified it to be permanently "turned on." By injecting an extra copy of the turned-on version of the gene into white pines, Canadian researchers have created trees with built-in resistance to the disease. Such trees will provide an alternative to the fungicides currently used to control the disease.

HARVESTING

Many recent innovations in harvesting methods and machinery have come about in response to public concerns over logging practices and their effects on environmental and aesthetic forest values, increasingly restrictive government regulations, and a growing understanding of natural systems.

Cost also has been a driving force behind these innovations. The cost of harvesting is a significant component of the total cost of fibre delivered to a mill, which in turn is often the largest component of a product's total cost. Therefore, keeping harvesting as cost-effective and productive as possible is a large part of remaining competitive.

Leaving a Softer Footprint

In 1991, FERIC conducted a survey among forestry operations personnel in eastern Canada to gather information about emerging needs for logging equipment. Respondents noted that preserving soil and water quality was a major concern, and they expressed interest in equipment that would reduce ground disturbance and prevent the sedimentation of waterways.

Logging roads frequently intercept small streams, and culvert installation is therefore a routine part of road construction. When logging equipment travels over poorly stabilized culverts, stream banks can erode and cause the streambed to silt up. This sedimentation can damage fish-spawning beds and aquatic ecosystems. Canadian engineers have designed a plastic head wall that can be clipped onto both ends of a standard-sized culvert to protect the streambed from erosion. The head walls have proven to be both solid and effective in protecting water quality and are now used extensively throughout the country.

Meanwhile, one Canadian company recently began manufacturing a cost-effective, bridge-like structure for crossing environmentally sensitive streams. Unlike conventional culverts, this structure retains the natural stream bottom and thus better preserves aquatic habitat.

BUFFERING THE EFFECTS OF FOREST BIOTECHNOLOGY

Although biological control agents are supplanting synthetic chemicals as the weapons of choice against insects and weeds, there is concern that the new genetically engineered pathogens may pose new and different threats to the environment. For example, there is some concern that genetically altered super trees may undermine the diversity of the natural gene pool, and that genetically engineered viral pathogens may impact aquatic life and vital microorganisms and invertebrates in the soil.

Forest biotechnology research is therefore addressing issues related to the flow of genes from transgenic trees into wild populations, and to the long-term stability of introduced genes and the potential long-term effects on the ecosystem of transgenic trees and genetically modified pathogens. Such studies have become a routine part of biotechnology research in both government- and industry-led projects. In addition, transgenic nurseries are designed with buffer zones to protect wild populations from contact with the new genetic lines, and research into new biological control agents is routinely coupled with environmental impact studies.

At the Insect Biocontrol Pilot Facility in Sault Ste. Marie, Ontario, CFS scientists have been studying viruses and other microorganisms, and their effects on critical ecological processes in soil and aquatic ecosystems. For example, laboratory bioassays have been developed to determine whether viruses used on the gypsy moth and spruce budworm affect other insect species. New laboratory methods now make it possible to detect the presence of foreign DNA in the environment and to track the fate of both natural and genetically modified DNA in forest soil and litter.

At the policy level, the Canadian Biotechnology Strategy was revamped in 1998 to ensure that the expanding field of biotechnology will be appropriately regulated. The new policy framework incorporates social, ethical, health, environmental and regulatory considerations.

Conventional logging operations also cause ground disturbance that can compact and erode the soil. To minimize this disturbance, several log-transport companies in western Canada have fitted their fleets with systems that enable the driver to adjust tire pressures on the fly. This central tire inflation (CTI) technology improves traction and reduces the rutting and compaction of logging roads. These CTI systems are expensive, however, because they are used on all tractor-trailer tires.

Canadian engineers have developed a simplified version of the CTI technology that can be installed on the drive axles alone. At half the cost of conventional units, the new system serves a much wider market. The technology, which has been performance tested across Canada in various applications, is also being considered for installation on timber harvesting equipment.

Researchers are now testing road-building methods that take advantage of the growing use of CTI-equipped logging trucks. Because these trucks leave a lighter footprint, logging roads need not be designed to support heavier traffic. This translates

into both decreased road construction costs and faster rehabilitation of logging roads after harvesting.

WHEELED SKIDDERS

It is generally acknowledged that two men, a Canadian and an American, independently came up with similar concepts for a better vehicle for hauling logs out of the bush. In any case, when wheeled skidders hit the market in the late 1950s, they were an overnight success in the logging industry. They offered the unique feature of steering from an articulated centre. Within approximately five years, skidders had replaced not only horses, but also many of the small caterpillar-type tractors of the day. Today, there are thousands of skidders used around the world.

The damage done by skidders as felled timber is dragged to the roadside can be the greatest inhibitor of natural forest regeneration. In some western Canadian operations, where valuable timber grows on steeply sloping terrain, cable yarding and helicopter logging are the only viable means of extracting timber. Although both of these methods cause less ground disturbance than skidding, helicopter logging is too costly to be viable in most other parts of Canada. Canadian-designed cable yarding, on the other hand, uses a system of aerial cables to hoist trees to the roadside and thus poses less of a cost barrier. Although it is more costly than ground skidding, cable yarding has proven to be the only currently available way of extracting trees on poorly drained, unfrozen ground without causing unacceptable levels of rutting. Operators in central and eastern Canada are now beginning to use this technology on spruce bogs and clay belts.

Making a Better Cut

Selection cutting—harvesting selected trees in a stand of uneven age—is a method that satisfies dual objectives: the pre-commercial thinning yields extra timber, and the growth conditions are improved for the younger trees and seedlings. Yet selection cutting in hardwood stands has been difficult to mechanize, largely because machine harvesting is difficult at night, when visibility is poor. The inability to run a night shift has in turn meant that production is too low to justify a capital investment in specialized equipment.

To address this problem, a feller-buncher has been outfitted with a GPS navigation system to test its effectiveness for nighttime harvesting. Researchers have found that with the GPS system, the operator can use the information displayed on the system monitor to plan the route more accurately, navigate better within the cut block, and locate the trees marked for cutting. GPS navigation systems are still being refined to make them more reliable, accurate and easy to use. Nonetheless, many agree that GPS has exciting potential for harvesting in the not-too-distant future.

Another area of technology that many believe will soon revolutionize timber harvesting is robotics. Quebec is currently host to a large, multi-player experiment integrating robotics technology into forest equipment. Known as "ATREF" (Application des technologies robotiques aux équipements forestiers), the project has resulted in some forward-looking applications that may soon find their way into mainstream harvesting.

One development from the ATREF project has been an on-board computer system to control the operation of harvesting machinery. The control system, which combines elements of information technology, robotics and human–computer interaction, makes it simpler for the operator to coordinate the movement of harvester attachments. Currently, to move an attachment in a coordinated way—say, to guide the processing head away from the cab at a constant height—an operator must manipulate separate joysticks to directly control the hydraulic valves involved in the movement. But with the computerized system,

the operator can use a single joystick to "tell" the computer how to move the machine's hydraulic valves to create the motion. The result, particularly if this new technology expands into a complete on-board control system, will be that an experienced operator will be able to concentrate less on routine machine manipulations and more on strategic decision making.

Another component of the ATREF project, one also related to harvesting, was the creation of a computerized training system for forest machinery operators. With today's sophisticated machinery, operators need more training than ever before. By enabling novices to accumulate practice time in the classroom before entering the cab of a machine, ATREF's graphic simulation software can minimize downtime and productivity loss in the field, and make training safer and less expensive. Students who complete training on the simulator are 15% more productive in the forest, and have 30% fewer equipment problems than other students.

Underwater Logging

The recovery of underwater wood holds the potential for increasing the available fibre supply in some regions of Canada. In British Columbia (B.C.), for instance, an estimated 28 billion m^3 of potentially usable timber is underwater. An even larger amount is in Quebec, often on land flooded in the aftermath of dam construction. But the time and cost involved in harvesting submerged trees seldom pays off, largely because of the inefficient harvesting systems employed. Whether forest companies use divers or robotics to harvest underwater timber, such trees could previously only be harvested one at a time. However, a recent Canadian innovation called the "Cutter" can dramatically lower the cost of bringing submerged wood to the surface.

The Cutter consists of two components: a cutting head that goes under the water and a control barge that stays on the surface. Equipped with video cameras, radar and sonar, the single-operator barge locates underwater trees and guides the cutting head, which can descend as far as 2 km. The head then clamps around the tree, cuts it, and punches an air bag into its trunk if the wood is not buoyant enough to float to the surface on its own. The control barge does more than harvest—it can also be outfitted with equipment to delimb trees or chip them for pulp, depending on their condition. The end product can then be boomed or transferred onto another barge for transportation. Because a single-control barge can be equipped with multiple cutting heads, one person is able to harvest hundreds of logs per day, making the operation much more productive and cost-effective than current methods.

SMART MANUFACTURING

As the Canadian forest industry rises to today's challenges—controlling delivered wood costs, coping with a potentially diminished softwood supply, competing in a fierce global marketplace, and respecting the environment and other non-timber values—making the most of the forest resource is paramount. In recent years, the industry has turned its attention to using available fibre supplies more efficiently. These efforts have taken several forms, including:

- recovering more of the forest resource, either by increasing the recovery of usable product or by finding applications for formerly under-utilized or unusable resources;
- developing value-added and other innovative forest products that meet today's market demands; and
- making use of wood by-products and wastes that were formerly discarded.

Fulfilling these objectives has led to innovation on numerous fronts: creating new processes, using unconventional resources in innovative ways, developing original products, and seeking out and studying new markets. Technology has been indispensable to the Canadian forest industry as it

CANADIAN FOREST MACHINERY: SMART DESIGNS, SMART HARVESTING

Some of the most interesting innovations in harvesting equipment recently have been coming off the drawing boards of small Canadian manufacturers. Basing their designs on today's needs—to adapt to difficult terrain, to meet environmental criteria, to maximize productivity, and to satisfy operators—manufacturers are coming up with smart equipment tailor-made for harvesting in Canada.

Timrick Welding & Machine Ltd., a small fabricating shop in Manitoba, has been building cut-to-length mobile slashers since 1995. Because each unit is hand-built and fully customized to purchasers' needs, Timrick is finding its slashers are in high demand, particularly in Manitoba and northwestern Ontario. The Timrick slasher boasts numerous unique features and options, including a 360°-rotation log loader, which means the truck can be positioned anywhere near the slasher, and a heel design with a 100° rotation, which gives the slasher the leverage it needs for very tall trees, such as aspen. As well, thanks to the input of operators, the slasher cab is larger than others on the market and offers unique soundproofing, as well as a one-of-a-kind airflow system for heating and air conditioning. The Timrick slasher also features a unique saw-linkage assembly for truer and wider cuts, which means more timber per hour, as well as a tilting deck that automatically dumps leftover woody debris. This way, the operator does not have to leave the cab to manually remove debris, improving productivity and safety.

In B.C., Kootenay Manufacturing Co. Ltd. (KMC) has developed a skidder that is well outfitted to harvest in environmentally sensitive areas. The machine is equipped with a hydrostatic drive for optimum manoeuvrability, an important consideration for low-impact operations. Because the skidder is also narrower than most, it is easier to navigate in tight spaces, making it ideal for thinning and selective cutting. In addition, the KMC machine has a low ground-pressure track that minimizes soil disturbance and, in combination with a directional control valve for steering, helps eliminate rutting. The skidder is particularly well-suited to sensitive soils, wet terrain and bad weather, and can handle slopes too steep for most other skidders.

Woodland Innovations Inc., a B.C. company that develops specialized forest machinery, has designed a singular piece of equipment that integrates harvesting with other forestry operations. The small (5-tonne) multi purpose forest vehicle, which comes with attachments for performing light roadwork and site preparation, as well as harvesting, loading and forwarding, is particularly well-suited to the B.C. forest environment.

comes to terms with evolving definitions of economic value from the forest.

Recovering More of the Resource

As succinctly put by Forintek, " Improved recovery is a goal that can be met only by innovation—by refining existing operations, by developing new and advanced processes, and by embracing the latest technologies."

With the objective of maximizing wood recovery, researchers at Forintek have been particularly aggressive in assessing new and existing sawmilling technologies and operations. Forintek studies have demonstrated, for example, that the addition of an optimized curve sawing system in a sawmill can increase wood recovery by up to 35%.

Also, Forintek has designed the Video Tooth Inspector (VTI), a quality-control system for

inspecting kerf saws. These thin saws are used in mills to increase lumber recovery, but they must have properly ground, well-maintained teeth for peak performance. Using video imaging, the VTI is able to assess a saw's condition and give the inspector detailed feedback about its wear and tear.

Underutilized Sources of Fibre

In the search for ways to recover more fibre, many in the industry have turned to resources that were traditionally overlooked, including underutilized and undesirable species, over-mature trees and low-grade wood. This attention to supposedly non-commercial species, and the innovation that can flow from them, is not an entirely new phenomenon.

One resource that many in the industry are focusing on in their attempts to improve usable wood recovery is small wood—short, small-diameter logs and tree tops. A current obstacle to efficiently processing this resource is debarking. The standard ring debarker, which scrapes the bark off a log, can be adjusted for smaller diameters, but after a certain point it begins to twist the stem, compromising the overall recovery.

To find an alternative to the ring debarker, FERIC has begun testing a single-stem debarker that operates with a milling head, which removes bark by taking a skim off the surface of the log. This portable small-wood debarker processes logs 50% faster than the ring debarker and offers greater recovery.

A small Canadian company—Aquila Cedar Products Ltd.—has based a growing business on remanufacturing low-grade and salvage cedar that would normally be almost worthless. Aquila builds and retails a wide array of garden products, including fencing, sheds, picnic tables, planters and ornamental items, using ultra-low-grade cedar lumber bought in random lengths from large forest companies. Aquila rips the rotten, split and knot-holed boards to recover usable pieces of clear and tight-knotted cedar, and then processes the leftovers into pulp chips or pallet stock for maximum recovery. In addition to its retail operation, the company also supplies short pieces to brokers and fabricators for use in planters, lawn edgings and hot tubs. Overall, Aquila roughly doubles the value of the low-grade cedar, which would otherwise be unusable.

WAFERBOARD AND ORIENTED STRANDBOARD

Waferboard, a plywood-like product developed in the 1960s, marked the beginning of a forest products revolution. While plywood is generally made of softwood, a much-in-demand resource, waferboard is made of aspen poplar, a previously neglected hardwood species. This new technology has resulted in an entire industry built around an easily regenerated hardwood species, and it has taken pressure off the decreasing supply of softwoods. Waferboard was first marketed successfully in Canada by MacMillan Bloedel Ltd. under the name of Aspenite™.

The successor to waferboard, oriented strandboard (OSB), is fast replacing plywood in new home construction in North America. OSB has also become a world commodity.

Wood-composite panels, such as oriented strandboard (OSB) and particleboard, are well-established examples of products that have evolved from a desire to take advantage of under-utilized or unusable resources. These panels have been joined in recent years by medium-density fibreboard (MDF), which is made from such materials as sawdust, wood shavings and recycled wood.

A new wood-composite panel also has been developed by the CFS and the Alberta Research Council. Waveboard, a corrugated panel made of wood wafers from small-diameter, low-quality trees, is stiffer and stronger in relation to its weight

than other flat panels and is ideal for such applications as roof sheathing, subflooring, siding and concrete forms. Waveboard also offers cost savings compared with other corrugated materials.

In the pulp sector, western Canadian mills have been facing shortages of high-quality chips in recent years as a result of less forest area being available for harvesting. Consequently, pulp mills are having to consider such non-traditional sources of fibre supply as over-mature and damaged stands, woody debris and small-diameter trees. FERIC, Forest Renewal B.C. and the pulp industry are examining processes and technologies to extract a reasonable amount of fibre from these resources.

Northwestern B.C., for instance, is home to extensive stands of hemlock and balsam, but most of these trees have only a thin shell of solid wood, and debarking is difficult, wood recovery is low, and harvesting and transportation costs outweigh the value of production. To tackle this problem, Canadian researchers are developing methods to chip whole trees in the woods and at satellite yards and to truck the chips to a mill. Because chip quality is essential to the viability of such harvesting, a number of innovations are being refined: advanced screening equipment; optical sorting technology that can remove bark, dirt and rot from the chips; and a bin-type debarker–processor that turns small-diameter tops and log chunks into bark-free chips. Innovative sorting processes and technologies will soon make chipping woody debris from sort yards, roadside operations and portable sawmills a reality—serving the dual purpose of supplementing the fibre supply and disposing of debris in an environmentally acceptable way.

CREATING AND MARKETING VALUE-ADDED PRODUCTS

Many in the forest sector believe that a more diversified, market-driven and innovative value-added sector is critical to maintaining a healthy forest industry and economy in Canada. "Value-added" simply means processing raw material so that its end value is greater than its original value plus the cost of processing.

Every stage of processing adds value to the forest resource, and many products that are considered "commodities"—lumber, panels, veneer, shakes and shingles, and newsprint—have had value added along the way. The distinction between "commodities" and "value-added products" generally rests on how many value-added bits go into the finished product, and the extent to which the product fills a particular market niche. Innovations that add a significant amount of value at one fell swoop are rare, perhaps with the exception of some engineered wood products, such as Parallam, Glulam and laminated veneer lumber. Usually, value is added bit by bit.

Value-added products offer many advantages; however, they are also associated with certain pitfalls, most notably increased tariffs. For example, most Asian countries impose stiff tariffs on value-added products, such as printing and writing papers. In an effort to avoid tariffs, some Canadian companies have been inclined to export wood commodities and add value in the destination country. The profit made from the sale of these value-added products comes to Canada, but the opportunity to develop a strong value-added sector at home—and the jobs that would stem from it—is lost.

Market Research

Because value-added forest products are specialized and often innovative, market research and market requirements are crucial components of successful production. Simply put, value-added products offer additional value only if the market is willing to adopt and pay for them.

Within the forest industry, the recent trend toward more and higher value-added products has brought with it a renewed emphasis on sound market knowledge. In fact, for many in the value-

A NEW DIMENSION TO WOOD-CHIP REFINING

CHIP REFINING A BIG INDUSTRY

Wood-chip refining, also known as "thermo-mechanical pulping," has been a major part of Canada's pulp and paper industry for many years. (Pulp is used to produce newsprint, magazines, catalogues, paperboard and tissue.) Chip refining makes pulp with properties close to those of more expensive chemical pulp. What is more, its high yield makes it an environmentally sound process. To illustrate: for 100 trees taken from the forest, chip refining produces roughly 94 trees' worth of paper, while some chemical processes produce as little as 50 trees' worth.

CONVERTING CHIPS INTO PULP

Chips and water are converted into fibre when they are fed into two large rotating disks that can be up to 2 metres in diameter and weigh several tonnes. The largest refiners have up to 20 megawatts or 27 000 horsepower attached, the equivalent of 10 diesel locomotives.

When the fibres are first broken away from the chips, they are stiff and difficult to compress, and they bond poorly. As the fibres pass through the refiner, the discs exert enormous force—up to 30 tonnes—on the half-kilogram of fibres that lie between the discs. The fibres are flattened and softened in a second, rendering them suitable for making paper.

SCIENTISTS' WORK ADDS A NEW DIMENSION TO WOOD-CHIP REFINING

In 1998, two Canadian scientists were recognized internationally for years of groundbreaking research that has added a new dimension to the process of turning wood chips into pulp. The scientists received the Marcus Wallenberg prize, the forest industry's "Nobel prize," for their on-going research into the wood-chip refining process and for developing a theory that relates energy input to pulp quality. This research has been carried out for some 20 years at the Pulp and Paper Research Institute of Canada (Paprican).

Although wood-chip refining has offered several advantages over chemical pulping, its main disadvantage has been its high energy consumption and cost. However, this latest research from Paprican shows that the energy consumption can be reduced significantly. Equally important, Paprican now possesses the know-how that will enable the pulp and paper industry to make chips for high-quality pulp from a broader spectrum of tree species.

Over the years, the two scientists analyzed the forces that act on wood chips in refiners (e.g., steam pressure and water temperature) and developed a series of calculations on ways to maximize pulp quality and minimize energy consumption. The work of these two Marcus Wallenberg prizewinners has also led to other improvements in the industry. For example, their research has greatly influenced the design of all of the pulp process machinery in use throughout the world today.

added sector, research into customers' needs and wants is the first consideration. Increasingly, producers are looking to the market to tell them what sorts of value-added products are desirable, rather than creating products and then searching for markets.

One project that illustrates how an innovative approach to marketing can pave the way for increased value-added production is Forintek's Japanese market study. This project takes a novel "attribute" approach to market analysis, concentrating first on identifying the specific attributes Japanese consumers seek in wood products. With the help of advanced polling and statistical analysis techniques, the research team has collected valuable details about Japanese buyers' preferences

ENGINEERED PRODUCTS

Canada is a world leader in the development of value-added wood products. Particularly during the past decade, the benefits of the following Canadian engineered products have become well-known and their use in the construction industry has become firmly established.

Canadian-developed Glulam (glued-laminated timber) is manufactured by gluing together individual pieces of end jointed and horizontally stacked layers of dimension lumber under controlled conditions. This structural product is used for headers, beams, girders, columns and heavy trusses, and it can be manufactured in an almost limitless variety of straight and curved configurations, offering architects artistic freedom.

Laminated veneer lumber (LVL)—also a Canadian innovation—is a layered composite of wood veneers and adhesive. The veneering and gluing process enables large pieces of LVL to be manufactured from relatively small trees, providing for the efficient utilization of wood fibre. Although it has varied uses, LVL is used primarily for structural framing in residential and commercial construction, and it is well suited to applications in which open web steel joists and light steel beams might be considered.

Parallam™ is a Canadian product whose name quickly became recognized around the globe. This high-strength structural composite lumber product is actually parallel strand lumber (PSL) that is manufactured by gluing strands of wood together under pressure. This process enables high-load-carrying beams to be manufactured in lengths that are limited only by transportation restrictions. Parallam is an attractive material that is well suited to applications in which appearance is important, although it can also be used for concealed applications.

Prefabricated wood I-joists are made by gluing solid lumber or LVL flanges to a plywood or oriented strandboard (OSB) panel web to produce a dimensionally stable, light-weight joist or rafter. The uniform stiffness and strength of these products and their light weight make them well suited for larger spans in both residential and commercial construction. As well, their high strength-to-weight ratio (a 24 cm x 8 m joist weighs just 23–32 kg) enables them to be installed manually, offering advantages in terms of labour and costs.

in texture, structural efficiency, finish, treatments, price range and other wood product characteristics. The next step is to make linkages: to locate existing Canadian products that possess these desired attributes and to identify opportunities for launching new value-added products that fit the market. The project will also link Japanese market opportunities with the realities of Canadian wood supply, and will identify the current or new technology needed to create the desired value-added products.

Although the Japanese market project is Forintek's first large-scale, attribute-based market study, researchers have been developing products and designs in response to specific market needs for some time now. Forintek's seismic research project is a case in point. In response to a worldwide desire for building designs that are tailored to withstand the forces of earthquakes, fires and wind, the project has resulted in new construction standards and products that meet the market need for structural stability and safety.

From its inception, the seismic project has been international in scope, involving scientists and institutions from Canada, the United States (USA), Japan, Australia and Italy. In essence, it is aimed at accumulating data and specifications to show designers and international standards committees that properly engineered wood structures are naturally resistant to seismic forces and to the fires that often ensue.

WOODWORKS® DESIGN OFFICE

A new software product developed in Canada makes it easier for engineers and architects to build non-residential buildings with wood instead of the more traditional concrete and steel. The WoodWorks® Design Office, developed by the Canadian Wood Council, can take a complete building layout and estimate sizes for all of the wooden structural elements, from beams and columns to stud walls. The product also offers the design of various types of connections, as well as the design of shear walls to withstand earthquakes and heavy winds. (A separate software program has been adapted for use in the USA.)

Already, the seismic research is paying off for the Canadian wood industry. For example, based on the results of extended testing and earthquake simulations, Japan has approved a new building standard that permits the horizontal application of plywood wall sheathing without blocking. This change permits greater use of Canadian plywood in Japanese house construction. The Forintek project has also led to the development of an innovative shear wall concept called "MIDPLY™," which provides greater earthquake resistance while using standard building materials.

Production

The development of value-added products may be driven by consumer needs or desires or by industry goals or constraints. Often, more than one consideration is behind the effort and more than one objective is met by the result. What follows is a brief look at three innovative products developed by the forest sector.

In the wood products sector, many sawmills are welcoming value-added production as an economically sound way of using smaller timber. In particular, finger-jointing is gaining popularity as a value-added process for lumber smaller than the conventional two-by-four.

Currently, Canadian sawmills can manufacture finger-jointed lumber that is specified for vertical use (e.g., interior wall studs). However, one Quebec sawmill is working with Forintek and the National Lumber Grading Association to establish a standard that will permit the production of finger-jointed products for horizontal use, expanding the market for finger-jointed lumber.

PAPRIFORMER

The 1960s saw a new way of forming sheets of paper that revolutionized paper's appearance. In Canada, the new twin-wire technology led to the invention of the Papriformer by Paprican, whose research and development into the new technology paralleled work in other parts of the world.

Traditionally, paper making involves spreading pulp on a screen and draining the water from one side. However, this method leaves the two sides of the sheet with different properties. By contrast, the Papriformer drains the water from both sides, producing sheets with the same uniform finish on each side.

As another example of value-added wood products, Timbre Tonewood Ltd. multiplies the value of salvaged cedar blocks by turning them into guitar soundboards (the frontpieces of acoustic guitars) that can fetch as much as $70. The salvaged cedar, which would normally be used for shakes and shingles or might even end up chipped, is carefully cut to preserve the grain—an

A BETTER WAY TO TEST LUMBER STRENGTH

The lumber used in building is graded for strength to ensure that it meets acceptable building and safety standards. For years, the strength properties of lumber were based on tests conducted on small samples that were straight-grained and defect-free—samples that did not reflect the type of wood used in the real world.

The "small-specimen clear-wood test" made the basic assumption that lumber strength was in direct proportion to the strength of the clear-wood samples. A small piece of "perfect" wood would be tested, and then the actual lumber would be docked points for flaws, such as the size of knots. That system has been compared to testing a piece of cement to judge how a concrete structure would perform. In other words, it was less than accurate and it short-changed the true strength of some species of lumber.

In the late 1960s and 1970s, several Canadian researchers began to question the validity of clear-wood testing and conducted their own tests, which led to today's "in-grade testing" system.

The new system tests full-size pieces of lumber rather than tiny samples, and many pieces are tested to measure bending, tension (pulling) and compression properties. The new method has proven more accurate and contributes to a more efficient use of wood, wasting less of a valuable resource.

As a result of the new system, some lumber values have increased and others have decreased. Overall, however, the design values for Canadian lumber have risen. The structural properties for spruce lumber, for example, have increased by 25% in some cases.

The reputation of the in-grade test is making its way around the world. Canada adopted the new system some 15 years ago; the USA, about 8 years ago. Gradually other countries—Japan, New Zealand, Europe and Australia, to name a few—are changing over to the in-grade testing system.

operation that requires specially designed equipment. If a block is not of soundboard quality, it is cut into a thicker piece for bracing stock, which is placed inside a guitar to support the soundboard. Timbre Tonewood exports more than 70% of its production, most of it to the USA, Europe and Japan.

In the pulp and paper sector, a new solution to the age-old problem of paper yellowing may soon open the door to more value-added products made with mechanical pulp.

There are two basic grades of pulp—chemical and mechanical. Mechanical pulp is less expensive to produce than chemical pulp and does not require added chemicals, meaning that it has less of an environmental impact. In addition, its production requires less fibre. Unlike chemically processed pulp, mechanical pulp retains the wood's lignin, meaning that more of the original tree is used and fewer trees need to be harvested to produce a given quantity of paper.

Mechanical pulp, however, has always suffered the drawback of yellowing when exposed to light, making it suitable only for newspaper, circular paper and other papers with a limited shelf life. Researchers with the Mechanical Wood-Pulps Network (one of Canada's Networks of Centres of Excellence) discovered why mechanical pulp turns yellow, and a Canadian chemical company used that knowledge to solve the yellowing problem. In a breakthrough shared with the Pulp and Paper Research Institute of Canada (Paprican), the company found a chemical that can prevent the yellowing of mechanical pulp, opening up a range of high value-added, long-life paper grades that researchers say could eventually double or even quadruple the global demand for mechanical pulps.

A NEW APPROACH TO WASTE

At the downstream end of forestry operations are a host of innovations that are mitigating the environmental impact of transforming timber into pulp, paper and other products, and are turning wood residues and waste into something of value. Traditionally, companies either burned leftover material as hog fuel to generate power for mills or disposed of it in landfills. But now environmental regulations in many provinces have restricted or even prohibited burning and landfilling, leaving the industry to seek alternative disposal methods. As well, in the current climate of dwindling fibre supply, there is high support in the forest sector for getting as much as possible from the resource.

Fly Ash

Most mills burn at least a portion of their wood residues, generating an estimated 3 million tonnes of fly ash annually worldwide. Only approximately 10% of this ash is reused, although emissions regulations in Canada require that it be recovered from the flue gases. Traditionally, fly ash has been collected in surface impoundments or been sent to landfills. But environmental concerns and limited land availability have made the disposal of fly ash increasingly unacceptable and costly.

In a recent effort to tackle this problem, University of Alberta engineers began investigating other possible beneficial uses for the 40 000 m^3 of fly ash generated each year by Alberta-Pacific Forest Industries Inc. The researchers found that combining fly ash with soil and gravel produces a mixture that can improve roadways, including logging roads. The fly ash can be applied damp or dry using conventional road-building equipment. The final product is further improved by adding lime by-products from pulp mills to the fly ash–soil mixture, significantly increasing the weight-bearing capacity of certain types of soil.

Bark

Bark is a huge by-product of wood processing: some 12 million tonnes of bark residues are produced by the forest industry in Canada each year. With the advent of environmental

BARK BOARD

Bark board, a panel made from otherwise unusable bark residues and produced without synthetic adhesives, seems an ideal wood product for the new millennium. Not only is it strong, durable, value-added and environmentally sound, but it can also be produced at low cost. These factors give the innovative product a competitive edge in the marketplace.

Researchers at Forintek are predicting that bark board will appeal to numerous North American markets. Its high water resistance makes it ideal for floor underlay, door stock, shingles and decking, and its low production cost makes it a competitive alternative to wood and non-wood siding applications.

Forintek researchers are also optimistic about bark board's acceptance in Pacific Rim countries, particularly because of its proven resistance to termites. The Japanese housing market in particular may represent an excellent opportunity for bark board. The panel's high compression strength and its resistance to water, decay and termites make it an ideal sill plate (the wood layer placed on top of a concrete foundation to support the posts in post-and-beam construction—the traditional home construction method in Japan). With market studies revealing that Japanese customers are increasingly wary of chemical wood preservatives and treatments, bark board may be an attractive natural alternative.

regulations restricting the disposal of bark, Canadian researchers are perfecting processes to turn bark into a usable panel, comparable to wood composite products. Also, recognizing that no one industrial application can realistically absorb the huge volumes of bark produced by the forest industry, other uses for this by-product are being investigated.

In one promising project, researchers have evaluated the adhesive potential of eastern Canadian bark by testing whether phenolic compounds extracted from it make effective resins. Researchers have used the resins made with bark phenolics in fabricating OSB panels that, when subjected to tests, proved as strong as liquid phenolics. Using bark in wood adhesives has an added environmental benefit: extracting polyphenolics and tannins from bark lowers its environmental impact if it is used as a soil conditioner or is landfilled.

Closed-loop Processing

Canada's pulp and paper mills are moving gradually toward closed-loop processing, a system in which all effluents are recycled back into the mill. Driven by increasingly stringent effluent regulations and the rising cost of raw materials and waste disposal, system closure not only enables manufacturers to get the most out of their inputs, but it also reduces the costs associated with decontaminating effluents.

The world's first closed-loop pulp mill opened in 1992 in Meadow Lake, Saskatchewan—an area where the nature of the water source dictated an innovative approach to effluent handling. The mill now produces 280 000 tonnes of bleached chemi-thermo-mechanical pulp each year without discharging any effluent. Instead, the wastewater is evaporated, and the concentrate is oxidized in a chemical-recovery boiler that produces sodium carbonate ingots. These ingots are partially reused, and approximately 95% of the energy required for evaporation is recovered. The water recovered in the evaporation stage is biologically treated and filtered before being reused in the mill. Since 1992, older mills have been retrofitted to achieve system closure—reducing the mills' impact on the environment, and generally having the added benefit of reducing energy costs.

Recently, Domtar Paper's mill in Trenton, Ontario, also went to a closed-loop process water system. In this system, the water and wash liquor from the semi-chemical pulping process are blended, evaporated and then recondensed. The resulting water is reused throughout the mill as a replacement for fresh water. (The closed-loop process produces enough water to fill an Olympic-sized swimming pool every two days.)

For plants that have not yet moved to closed-loop systems, new technologies are being devised to reuse the contaminated water in mechanical newsprint mills. Researchers are working on a membrane biological reactor, a type of filter that can be used to treat water in pulp mills. Treating recirculated water inside mills reduces the amount of fresh water used and the volume of effluent discharged. Several research institutions also are working to develop and refine biofilters (organic substances that reduce toxic emissions and odours).

To address another long-standing concern with respect to effluents, scientists in Canada's Sustainable Forest Management Network are studying how to lighten the colour of wastewater discharged by pulp and paper mills. Because process water is tinted by tannins, the discharge tends to absorb more light and heat and retain less

oxygen than unprocessed water—attributes that can negatively affect plant and animal life in lakes and streams. Network researchers are experimenting with ways to lighten the colour of this wastewater by combining a fungus found on decaying wood with the ozone found in mill aeration lagoons.

The Search for Friendlier Bleaches

Canada's pulp and paper industry has virtually eliminated dioxins and furans from its effluents by switching from elemental chlorine to chlorine dioxide, and by removing lignin from pulp before the bleaching process. These changes in bleaching methods have enabled some producers to cut their organochlorine emissions by more than 80% since the late 1980s. Still, the search continues for safer and cheaper biological alternatives to chemical bleaching agents and methods.

Paprican is studying the viability of bleach alternatives, such as ozone, activated oxygen and enzymes. So far, despite years of testing, ozone holds perhaps the least promise as a bleach alternative because it weakens the pulp's strength and uniformity. Activated oxygen is still in the early stages of development, but it is proving effective as a brightener and for removing lignin from chemical pulps.

Enzymes, the third alternative, are biochemical molecules that can supplement, or perhaps even replace, the chemicals that extract lignin in the bleaching process for kraft pulping. Scientists in the Protein Engineering Network have altered two enzymes—lactase and manganese peroxidase—to make them oxidize chemical pulps more efficiently. The objective of this continuing research ultimately is to minimize the quantity of enzymes and energy required in the bleaching process. Besides delivering the environmental benefit of energy efficiency, these bleaching techniques are expected to accelerate paper production and reduce costs.

Improving Energy Efficiency

In addition to reducing emissions and effluents, some Canadian pulp and paper mills are demonstrating environmental stewardship by reducing inputs, such as electricity, water and trees. As an example, in a process known as "cogeneration," steam produced by the burning of sawmill residue is now being used as an energy source, powering turbines that generate electricity. One Canadian pulp mill is not only generating much of its own electricity, but is also producing enough steam to satisfy its entire process and utility steam requirements.

ETHANOL FROM WOOD

Through a process called "enzymatic hydrolysis," enzymes attack cellulose and convert it into sugar. The sugar is then refined into ethanol. Used as a partial replacement for regular gasoline, ethanol-blended fuel produces fewer greenhouse gas emissions than regular car fuel.

Converting forest residues (e.g., chips and sawdust) into ethanol fuel is the long-term goal of Iogen, a Canadian biotechnology company. In the meantime, Iogen will rely on agricultural biomass (e.g., wheat straw and corn cobs) for its ethanol-producing plant.

The redesign of recovery boilers not only has major implications for reducing air pollution, but it also improves the recycling of costly inorganic compounds used in pulp manufacturing. In the early 1990s, two University of B.C. engineers began looking for ways to improve the combustion performance of boilers, with the dual objective of optimizing the recovery of sodium hydroxide and reducing the emission of carbon monoxide and hydrogen sulphide. The two scientists developed several performance-enhancing modifications that are expected to save the industry millions of dollars annually in energy efficiencies and recovered inputs. The improved

combustion will also translate into much reduced emissions of sulphur compounds, which produce the rotten-egg smell usually associated with pulp mills.

Several Canadian studies are also looking at converting wood waste into a usable source of fuel. For example, one company is building a commercial-scale wood gasifier that will consume roughly 450 kg of wood waste per hour and produce a fuel suitable for powering a 75-horsepower diesel engine.

One fuel that is already being made from wood waste and is rapidly gaining popularity in Canada and abroad is pellet fuel. Wood pellets, which can be manufactured from almost any wood residue, including shavings, sawdust and even small amounts of bark, are formed under pressure, giving them high-energy calorific values. The domestic market for pellet fuel is swelling, thanks to sustained marketing and public education by pellet manufacturers. Sales in northern Europe also are expanding.

Recognizing this trend, B.C. pellet manufacturers have tapped into the Swedish market for pellet fuel—an especially promising niche given that Sweden, in its attempts to control carbon dioxide emissions, has increased taxation on fossil fuels. After negotiations with Sweden, several B.C. manufacturers formed a joint-venture company to supply pellets to a city of 80 000 on the west coast of Sweden. The city burns the pellets in a central heating system at dockside, creating steam to heat water that is then piped throughout the city to heat residents' homes.

STRENGTH IN INNOVATION

Canada's innovations and technology developments have been adopted by the forest sector worldwide. Our research results and innovative technologies have not only enabled our domestic forest sector to adjust to evolving public forest values, but they have also been a keystone to our competitive advantage in the forest products market.

As evidenced in the preceding pages, Canada has a tradition of innovative strength. It is generally recognized, however, that complacency could undermine all of our advances and threaten our competitive position. It is also generally accepted that public values toward the forest resource will continue to evolve and challenge the sector to adapt. Innovation is clearly the key to this ongoing adaptation.

SPECIAL ARTICLES

UPDATES on forest-related topics.

PROTECTED AREAS:
SAFEGUARDING CANADA'S BIODIVERSITY

The World Conservation Union (IUCN) defines a "protected area" as an "area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means." The IUCN has developed six management categories of protected areas *(see page 84)*.

In Canada, the federal government has some responsibility for forest conservation under acts governing national parks, migratory species, navigable waters and fish habitat, but the provinces have general constitutional authority for decisions regarding forest management and land use. The federal government does, however, engage in international agreements relating to protected areas and to the protection and conservation of biodiversity.

In 1992, the Canadian Council of Forest Ministers, which represents Canada's federal, provincial and territorial governments, agreed to a national forest strategy that called for, among other things, the completion of a network of conservation areas representative of the diversity of Canada's forests by 2000. That call was echoed by the ministerial councils of wildlife, parks and forests at a meeting later in the year.

The G-8 Action Programme on Forests strives to achieve a global assessment of the effectiveness of protected forest areas in maintaining forest biodiversity.

In 1995, the Canadian Biodiversity Strategy was prepared and endorsed by all provincial, territorial and federal governments as a national guide to the implementation of the Convention on Biological Diversity. The Strategy suggested criteria for selecting new protected areas and for promoting open and meaningful public and stakeholder participation in site selection. It also indicated a need to minimize adverse impacts and to maintain the connectivity around protected areas; and it called for inventories, plans, guidelines and monitoring programs for the establishment and maintenance of protected areas.

Approximately 83 million hectares are "protected" in Canada, and of that land, roughly 32 million hectares are forested. Less than half of Canada's forests are managed for timber production; the rest are considered "open" or inaccessible.

Also in 1995, a review of progress related to the 1992 National Forest Strategy noted less-than-anticipated progress toward completing a network of protected areas and consequently identified this goal as being of the highest priority. The restatement of the commitment to protected areas in Canada's new National Forest Strategy, endorsed in 1998, reflects this priority.

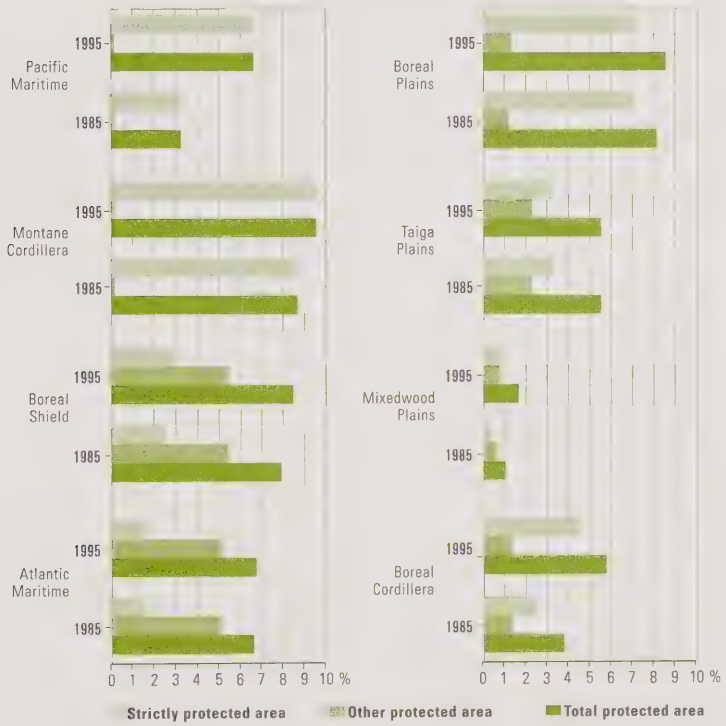
In 1998, the G-8 Action Programme on Forests (http://birmingham.g8summit.gov.uk/forfin/forests.shtml) called on Canada to achieve a consensus on the categories of protected areas, drawing on the IUCN protected areas management categories and other classification systems. It further suggested that Canada identify key forest types not sufficiently represented within the existing network of protected areas.

Although there continues to be a very high degree of interest in protected forest areas domestically and internationally, Canada faces a variety of challenges in meeting its current commitments—aside from the issues of overlapping responsibilities and coordination of efforts between governments. For example, there are no nationally agreed-upon principles for conservation planning; a definition of "representative" has not been formalized; and there exist literally hundreds of different categories of protected areas. Furthermore, Canada does not currently have an authoritative national mechanism to comprehensively collect and report on biodiversity data in relation to protected areas.

The provinces and territories tend to take action toward establishing protected areas according to their own circumstances, and decisions are frequently based on geography rather than biodiversity. Some provinces, such as Nova Scotia, Ontario and British Columbia, have made significant progress toward protecting "representative areas" in recent years. Other provinces and territories are involved in extensive consultations to reconcile the interests of the public and industry.

On the international front, challenges exist with respect to the classification, reporting and composition of protected areas. For example, there

FOREST AREA PROTECTED BY ECOZONE



Source: Environment Canada–Canadian Conservation Areas Database

is evidence of disagreement among countries as to what constitutes a "protected area," often resulting from either misinterpretation of, or disagreement with, the IUCN category definitions and/or scopes. Furthermore, some countries have adopted very strict interpretations of the IUCN categories, while others are more liberal in their applications. This makes international reporting and comparisons very difficult, if not impossible.

Despite these challenges, Canada does have a tradition of protecting its natural heritage and is internationally recognized for its many beautiful parks. In addition, government policies are collectively supportive of completing a network of protected forest areas. Moreover, Canada's most significant strength—its proven ability to reach consensus through multi-stakeholder consultations—will perhaps assist it in meeting its commitments to protect areas that are representative of the diversity of its forest ecosystems.

IUCN PROTECTED AREAS CATEGORIES

CATEGORY	DEFINITION
I Strict nature reserve/wilderness area	Protected area managed mainly for science or wilderness protection
II National park	Protected area managed mainly for ecosystem protection and recreation
III Natural monument	Protected area managed mainly for conservation of specific natural features
IV Habitat/species management area	Protected area managed mainly for conservation through management intervention
V Protected landscape/seascape	Protected area managed mainly for landscape/seascape conservation and recreation
VI Managed resource protection area	Protected area managed for the sustainable use of natural ecosystems

FOREST-DWELLING SPECIES AT RISK

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) uses the best scientific information available to determine the national status of wild Canadian species, subspecies and separate populations suspected of being at risk. Species deemed to be at risk are categorized and added to the national list of species at risk on a yearly basis. "Vulnerable" is used to designate a species that is of special concern because of characteristics that make it particularly sensitive to human activities or natural events; "threatened" identifies a species that is considered likely to become endangered if limiting factors are not reversed; and "endangered" describes a species that is facing imminent extirpation or extinction. ("Extirpation" refers to localized extinction.)

In spite of restrictions on international trade in wild ginseng, collection of the species in the wild remains a problem. In 1999, the status of wild populations of ginseng in Canada was changed from threatened to endangered.

Overall, 88 species were assessed or reassessed by COSEWIC in 1998–1999. The Committee found that 17 of the species were not at risk and delisted 3 other species. It also moved 3 species to lower risk categories because of improvements in their populations. In a number of other cases, the Committee decided that there was insufficient information to make a designation. By April 1999, COSEWIC announced that it had added 32 net species to the national list of Canadian species at risk.

Of the new species determined to be at risk, seven are dependent on forests *(see below)*. Criteria for forest dependence includes whether a species requires forests for food, shelter, breeding or other critical aspects of its life cycle.

More than half of all forest-dependent species at risk are associated with the Carolinian forests of southern Ontario.

Further information on COSEWIC is available on the Internet (http://www.cosewic.gc.ca).

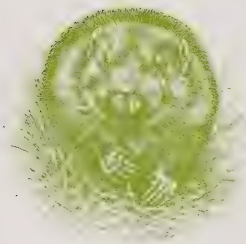
NORTHERN RED-LEGGED FROG

RANA AURORA

The northern red-legged frog is found in woodlands bordering streams, and it breeds in the cool shady waters of slow-moving streams, ponds and marshes. In Canada, it occurs on Vancouver Island and the southwestern mainland of British Columbia (B.C.). Females of this relatively large (up to 100 mm) brown and red frog lay their eggs in late winter. The eggs are attached to the stems of aquatic plants or submerged branches in large loose masses and hatch after a month. Competition with the introduced eastern bullfrog may have contributed to a decline in numbers. The northern red-legged frog was classified by COSEWIC as "vulnerable."

MOUNTAIN BEAVER

APLODONTIA RUFA



Ranging from southwestern B.C. south to California, the mountain beaver's ideal habitat is an open-canopy forest supporting succulent vegetation and cool moist surroundings with subsurface water. With strong front claws and almost no tail, this burrowing rodent constructs long, complicated burrows where the soil is suitable. The mountain beaver is the only living member of a family of fossil rodents unique to North America. Mountain beaver is not classified as a fur-bearing or game species, and its numbers and range can be affected by forest practices and urban, agricultural and industrial development. It was classified by COSEWIC as "vulnerable."

BICKNELL'S THRUSH

CATHARUS BICKNELLI

One of Canada's rarest songbirds, the elusive Bicknell's thrush has only recently been distinguished from its close relative, the gray-cheeked thrush. In the breeding season, it occupies inaccessible high-elevation, dense and stunted spruce forests in Quebec, New Brunswick, Nova Scotia and the northeastern United States (USA). The Bicknell's thrush winters on the large islands of the Caribbean. Canada has approximately one-third of the world's population. Population declines may be related to loss of habitat due to forestry operations, spruce budworm infestations, ski operations, acid rain and deforestation of its wintering grounds. It was classified as "vulnerable" by COSEWIC.

LEWIS' WOODPECKER

MELANERPES LEWIS

This medium-sized (26–28 cm) greenish-black woodpecker has a distinctive pinkish-red belly. The Lewis' woodpecker lives in the west, from central B.C. south to California, in open pine–oak woodlands, coniferous forests and riparian woodlands. It depends on large old trees for nesting and open areas for feeding. Suitable habitat is being lost through fire suppression and logging in ponderosa pine forests and to human encroachment in cottonwood stands. Pesticides and competition from the starling for nesting sites also may have had a negative impact. Breeding populations in southwestern B.C. have been lost, and the species was classified as "vulnerable" by COSEWIC.

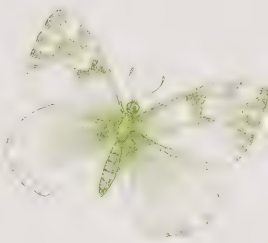
FROSTED ELFIN BUTTERFLY

CAOLLOPHRYS [INCISALIA] IRUS

A drably coloured butterfly of open second-growth oak–pine woods, the frosted elfin butterfly is found in the eastern USA, from Florida and Texas north to New England and Wisconsin. In Canada, it is known historically from only one locality in southern Ontario. Frosted elfin adults are small, with a wingspan of 22–24 mm, and are grey-brown in colour with a stubby tail on the hind wing. The pale blue-green larvae feed on wild lupine plants. The species prefers openings in canopied forests where lupines thrive. This elfin has not been seen in Ontario since 1988 and is on the provincial endangered list. It was classified by COSEWIC as "extirpated."

ISLAND MARBLE BUTTERFLY

UNDESCRIBED SUBSPECIES OF *EUCHLOE AUSONIDES*



This white and greenish butterfly, with a marbled texture under the hind wing and a wingspan of approximately 45 mm, is an undescribed subspecies of the large marble butterfly. Restricted to open grassland in the Garry oak woodlands of southeastern Vancouver Island, B.C., it disappeared from Canada before 1910. A small population was found on San Juan Island, USA, in 1998. The large marble butterfly is found from B.C. to Ontario. The most likely cause of the loss of the island marble butterfly is the elimination of the larval food plant from its habitat through grazing by sheep or cattle. The subspecies was classified by COSEWIC as "extirpated."

CROOKED-STEMMED ASTER

ASTER PRENANTHOIDES

Found along stream or creek banks, in wet thickets, and along the edges of woods, this pale blue or violet aster is partial to rich, sandy soil and full shade. This rare species stands up to 1 m high, and it is identified by a smooth zigzag stem and clasping leaves that are narrowed and toothless below the middle. Its floral bracts are narrow and translucent. Also rare or of uncertain status in its range in the northeastern USA, it is known from only three localities in southwestern Ontario. Small populations, restricted distribution and susceptibility to chemical runoff are reasons for COSEWIC classifying the crooked-stemmed aster as "vulnerable."

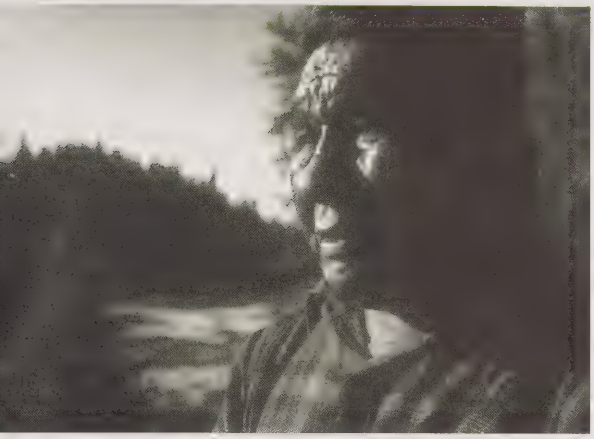
FOREST–DWELLING SPECIES AT RISK*

CATEGORIES	MAMMALS	BIRDS	PLANTS	REPTILES
ENDANGERED	Newfoundland pine marten Vancouver Island marmot Wolverine (eastern population)	Acadian flycatcher Kirtland's warbler Northern spotted owl Prothonotary warbler	American ginseng Cucumber tree Deltoid balsamroot Drooping trillium Heart-leaved plantain Large whorled pogonia Nodding pogonia Prairie lupine Purple twayblade Red mulberry Seaside centipede lichen Small whorled pogonia Spotted wintergreen Wood poppy	Blue racer (snake)
THREATENED	Wood bison Woodland caribou (Gaspé pop.)	Hooded warbler Marbled murrelet White-headed woodpecker Yellow-breasted chat (Montane pop.)	American chestnut Bird's-foot violet Blue ash Blunt-lobed woodsia Deerberry Golden seal Kentucky coffee tree Round-leaved greenbrier White wood aster White-top aster Yellow montane violet	Black rat snake Blanding's turtle (Nova Scotia pop.) Eastern Massasauga rattlesnake
VULNERABLE	Ermine (Queen Charlotte Island's pop.) Fringed myotis (bat) Gaspé shrew Grizzly bear Keen's long-eared bat **Mountain beaver** Nuttall's cottontail Pallid bat Southern flying squirrel Spotted bat Wolverine (western pop.) Woodland caribou Woodland vole	**Bicknell's thrush** Cerulean warbler Few-flowered club rush Flammulated owl **Lewis' woodpecker** Louisiana waterthrush Queen Charlotte goshawk Red-headed woodpecker Yellow-breasted chat (Carolinian pop.)	American columbo Broad beech fern Coastal wood fern **Crooked-stemmed aster** Cryptic paw lichen Dwarf hackberry False rue-anemone Green dragon Hop tree Old growth specklebelly lichen Phantom orchid Seaside bone lichen Shumard oak Wild hyacinth	Cœur d'Alène salamander Five-lined skink Mountain dusky salamander **Northern red-legged frog** Pacific giant salamander Wood turtle

**bolding indicates species added to the list in 1999*

Source: Committee on the Status of Endangered Wildlife in Canada (COSEWIC)

FIRST NATIONS AND FORESTS IN CANADA: RIGHTS AND TITLES



The relationship between the Aboriginal people of Canada and forest resources in the 21st century is being profoundly shaped and directed by developments at the close of this millennium. Traditional uses of forest resources by Aboriginal people will be enhanced and even altered through greater Aboriginal involvement in and control of the management of forests on a portion of the land.

EXISTENCE AND RECOGNITION OF RIGHTS

Section 35 of the Constitution Act (1982) declares that "existing Aboriginal and treaty rights ... are hereby recognized and affirmed." To be "existing," an Aboriginal right must not have been extinguished prior to the date the Constitution Act came into force. To extinguish an Aboriginal right, the Crown, Parliament or a pre-Confederation legislature must have manifested a clear and plain intention to do so. The exercise of an Aboriginal right may have been regulated for safety or conservation purposes, for example, but that does not mean that the right itself has been extinguished.

In 1996, the Supreme Court of Canada held that recognition of Aboriginal rights serves to reconcile Crown sovereignty with the reality that European explorers and colonists did not arrive in uninhabited land, but in land occupied by Aboriginal peoples with their own practices, customs and traditions. To be recognized as an Aboriginal right, an activity must be an element of a practice, custom or tradition that was, at the time of contact, integral to the distinctive culture of the group claiming the right. If an activity has evolved over time, it is necessary that continuity be demonstrated with the distinctive pre-contact practices, customs or traditions of the society.

Customary Use

Applied to forest resources, an existing Aboriginal right to harvest may be proven through historical, anthropological and other relevant evidence demonstrating that the harvest was integral to the society at the time of contact and that there is continuity with present customs, practices and traditions. In eastern Canada, the critical time frame is more than 500 years ago; in the western regions, it is approximately 200 years ago. For a claimant, proof of such an Aboriginal right presents a burden of evidence that is not insurmountable.

BALANCING RIGHTS AND BROADER COMMUNITY INTERESTS: LEGAL TEST

Once a claimant demonstrates that an Aboriginal right exists and has been infringed, the burden of proof shifts to the Crown to justify the interference with the constitutionally protected right. To satisfy this burden, the Crown must first demonstrate that the statute or regulation at issue has a valid

legislative objective (e.g., safety of the Aboriginal and non-Aboriginal persons involved in the activity, or conservation of the resource). The Crown must also demonstrate that requirements arising from the fiduciary nature of the Crown's relationship with Aboriginal peoples have been satisfied. For example, if conservation is the legislative objective, has the Aboriginal right been fairly considered in allocating the resource? Have the Aboriginal people concerned been consulted regarding the measures to be implemented? If there is an expropriation, is there compensation? Has the Aboriginal right been infringed as little as possible? This analysis is similar to that undertaken in relation to infringements of the Canadian Charter of Rights and Freedoms, as it centres on balancing the right at issue with the broader community interest.

TITLE LANDS

In addition to specific Aboriginal rights, Aboriginal title to forest lands may be claimed. Aboriginal title was the subject of the 1997 decision of the Supreme Court of Canada in Delgamuukw. The Court recognized two basic propositions as reflecting the essence of Aboriginal title. First, Aboriginal title represents a right to exclusive use and occupation, but unlike Aboriginal rights, it is not limited to distinctive customs, practices or traditions. Second, use of the lands pursuant to Aboriginal title must not be irreconcilable with the Aboriginal interest in the land.

The nature of the Aboriginal interest in the land is of particular importance. For example, if Aboriginal title is established in relation to hunting land, the Aboriginal title holders may not use the land for purposes inconsistent with hunting. This does not mean that only traditional activities may be undertaken on Aboriginal title land; rather, land uses must respect the reason for the recognition of Aboriginal title—to sustain Aboriginal society and culture. In addition, current occupation of lands does not establish Aboriginal title; rather, the lands must have been occupied prior to the establishment of British sovereignty. Lastly, failure to satisfy the requirements for recognition of Aboriginal title does not mean that the Aboriginal group has no rights in relation to the claimed lands; Aboriginal rights short of Aboriginal title may be found to exist.

DEVELOPMENTS IN EASTERN AND WESTERN CANADA

In 1998–1999, in New Brunswick, negotiation between on-reserve communities and the provincial government resulted in a number of agreements regarding logging on provincial Crown lands. These agreements are the indirect result of highly publicized litigation over an argued treaty right to harvest trees commercially. In the end, litigation did not deal with the merits of the claim because the evidence considered was inadequate to determine whether such a right existed.

The Government of New Brunswick entered into negotiations with the 15 Mi'kmaq and Maliseet reserve communities based on a total of up to 5% of the annual allowable cut and application of the provincial forest management plan. Interim agreements for the 1998–1999 period were reached with 14 of the 15 communities. In addition, some agreements were reached between Aboriginal communities and private timber licence holders, providing work to Aboriginals in logging and silviculture.

In British Columbia (B.C.), the on-going treaty-making process between Aboriginal peoples and the provincial and federal governments is the culmination of litigation and negotiation that may be considered to have begun with the historic decision of the Supreme Court in Calder (1973), which marked a recognition of the potential existence of Aboriginal rights and title.

In general, the treaties are meant to achieve certainty over rights to lands and resources through the sharing of lands and resources, the recognition of specific Aboriginal rights, and the assurance of no future claims to further rights or land. Currently, 51 First Nations in B.C. (representing roughly 70% of the First Nation population) are negotiating treaty terms with government. Of these, 3 are in the very early stages; 10 are negotiating framework agreements; 37 are negotiating agreements-in-principle; one, the Sechelt, is negotiating a final agreement; and one, the Nisga'a, has reached a final agreement.

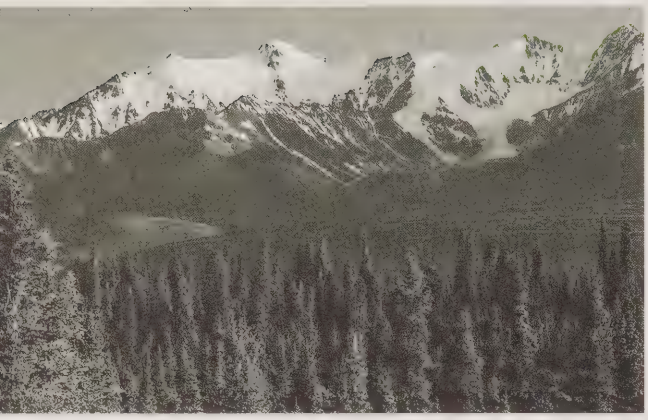
The 1998 draft Nisga'a Treaty provides for approximately 2 000 km^2 of settlement land within the Nisga'a traditional territory in the Naas Valley of northwestern B.C. The Treaty provides for a five-year transition period during which existing forest licences will be continued, and the Nisga'a will adopt rules and standards of forest practices that meet or exceed provincial standards. The Nisga'a will have authority to allocate timber and other harvesting rights through contractual agreements on the land to which they will hold title, and they will play a role in the use and conservation of lands adjacent to their settlement lands.

SUMMARY

Aboriginal rights litigation can be complex and lengthy, as well as being costly for the claimants, Crown and third parties. Recognizing this, the Supreme Court of Canada has repeatedly emphasized the desirability of negotiation, rather than litigation, as the means of resolving Aboriginal issues and has stressed the importance of its decisions as the legal framework for such negotiations.

Negotiation has already led to real results in terms of reaching agreements regarding the development of forest resources by Aboriginal and non-Aboriginal people. That process will continue into the 21st century.

CANADA'S NORTH:



Canada's northern territories—the Yukon, the Northwest Territories and now Nunavut (established April 1, 1999)—are distinct from the 10 provinces in that they are sparsely populated, with few settlements and fewer roads. They are, however, dominated by extensive wild lands and watersheds. In the case of the Yukon and Northwest Territories, forest resources are relatively abundant and diverse. In comparison to southern Canada, the natural resources of northern Canada are still largely untapped. For most northerners, the degree to which they control their natural resources is one of the defining differences between the territories and the provinces.

The transfer of responsibility for the management of natural resources in Canada's North from the federal government to the territorial governments is known as "devolution." Devolution of forest resources offers insights into the challenges and opportunities of other natural resource transfers, and the implications for the future of forest management in the North.

NORTHERN FORESTS

The popular image of the North as a land of snow and ice has tended to override basic facts about the forest landscapes of the Yukon and the Northwest Territories.

DEVOLUTION OF FOREST MANAGEMENT RESPONSIBILITIES

The Yukon's boreal forests cover 27.5 million hectares or 60% of the landscape, and are similar to those found in Alberta, Saskatchewan and Manitoba. Roughly a quarter of the Yukon's forest land—an area the size of New Brunswick (7.3 million hectares)—could sustain commercial timber production. The portion of this land that is accessible, however, is only 1.7 million hectares.

The Northwest Territories' and Nunavut's combined land base is seven times larger than that of the Yukon, but only approximately 20% is forested and virtually all of it is in the Northwest Territories. Nunavut has little forest cover. (The southern boundary of Nunavut is loosely defined as the northern boundary or timberline of the boreal forest.)

For the few, small territorial communities with access to timber-productive forest lands, the forest industry is an important contributor to local economies. In addition, northern forests are, in local and global terms, particularly valued for their wildlife and habitat attributes, their recreation and tourism potential, and the subsistence or traditional way of life they support.

The changing face of forest management in northern Canada is marked by two significant developments: the settlement of native land claims, and the on-going devolution of resource management responsibilities. These two developments, combined with the establishment of Nunavut, have introduced a period of profound institutional change in northern Canada that is somewhat analogous to the situation that occurred when the Resource Transfer Agreements were signed with the western provinces in the 1930s. (Legislation was enacted under the Resource Transfer Agreements to transfer control of the natural resources in Manitoba,

Saskatchewan and Alberta from the federal to the provincial governments.) The devolution of forest management responsibilities to the territorial governments is a bellwether initiative for the transfer of management responsibilities for other resources (e.g., minerals, inland waters, oil and gas.)

Devolution of other natural resources involves the transfer of resource management responsibilities. However, unlike the Resource Transfer Agreements, there is no transfer of resource ownership. In the territories, the ownership of resources is retained by the federal government, as the transfer of ownership can only occur constitutionally through the designation of the territories as provinces.

The responsibility for resource management and administration can be devolved independently of ownership through amendments to the Yukon, Northwest Territories and Nunavut Acts, assigning legislative and regulatory responsibilities and powers to the territorial legislative assemblies. This course has been pursued for almost two decades, since the establishment of governments with elected legislatures in the Yukon and Northwest Territories.

THE CONTEXT TODAY

Under federal responsibility, forest management in the Yukon and Northwest Territories was confined to fire suppression. With the increasing development and use of northern forests, the inadequacy of this approach became apparent. Competing land-use interests underscored the need for a new and innovative approach to forest management.

Since the mid-1980s, many northern communities have sought greater economic stability and have diversified their economic base and created employment through forestry-related development. Forest lands vary throughout the North and communities have sought to define their unique relationship with nearby forests. This has increased the public pressure on municipal, First Nation, territorial and federal governments for strong local input into decisions affecting timber supply analysis, sustainable forest management planning, multiple land-use planning, and the establishment of protected areas. The transfer of forest management responsibilities to the territorial governments has presented an opportunity to address these challenges.

Since forest fire protection and other forest management programs were devolved to the Northwest Territories in 1987, the territorial government has expanded the forest management program and adopted its own fire management policy. As well, fire management programs have evolved into community development programs with extensive participation from community organizations and local agencies.

The Yukon also is pursuing forestry devolution. Those discussions have been challenging, largely due to the relationship between devolution and the settlement of First Nations' land claims. In 1997, agreements between the Yukon government and Yukon First Nations enabled the transfer of oil and gas management responsibilities to the Yukon government. A devolution protocol accord was subsequently signed by Canada, the Yukon government and Yukon First Nations in 1998, setting out a mutually acceptable process for devolution. These agreements are seen as critical steps for forestry devolution in the Yukon.

THE OPPORTUNITIES

The negotiating challenges experienced in the Yukon have created certain opportunities. For example, in advance of forestry devolution, the Yukon has prepared itself to assume these new responsibilities and has established management arrangements that are unique in Canada.

The Yukon's 14 First Nation final agreements or land claim agreements (7 of which have been signed) establish in law the basic principles of

sustainable forestry and integrated resource management. They empower Yukon communities with a voice in resource management through the creation of local Renewable Resource Councils and regional land-use planning commissions. These agreements, along with the Yukon First Nations' Self-government Agreements, lay the foundation for strong working relationships among the Yukon government, First Nation governments and local communities in the cooperative management of the Yukon's forests.

In 1997 and 1998, the Yukon government undertook a territory-wide public consultation process that led to the adoption of the Yukon Forest Strategy. As a planning framework, the Strategy articulates a public vision for the management of Yukon forests, and it establishes the broad goals, objectives and principles for the development of made-in-Yukon forest legislation.

For the Northwest Territories and the Yukon, the limited forest management activities prior to devolution and the challenges faced during the devolutionary process have created unparalleled opportunities for innovative forest management post-devolution. The process has enabled the northern governments to undertake new approaches to forest management—approaches being fashioned through extensive public and community participation and an emerging and strengthening government-to-government relationship with First Nations. The result is a unique approach to the cooperative management of Canada's northern forests.

COSTA RICA–CANADA INITIATIVE

BUILDING INTERNATIONAL CONSENSUS

Since the Rio "Earth Summit" of 1992, Canada has been promoting a common international framework for sustainable forest management. Many nations, however, remain hesitant to commit to negotiating legally binding instruments on forests until there is a greater understanding of the elements of such agreements. In addition, there is general recognition that a number of important international forest policy issues remain unresolved.

Canada and other countries recognize that all parties need an opportunity to adequately reflect on a wide variety of forest issues and to consider a full range of possible legally binding instruments to address some of these issues, including a forest convention, for example. For these reasons, Canada and Costa Rica launched what is now known as the "Costa Rica–Canada Initiative" to provide a neutral forum for countries and interested parties to express their views on the potential elements and relative merits of legally binding international forest instruments.

In Canada, the lead organizations for this initiative include Natural Resources Canada (through the Canadian Forest Service), the Department of Foreign Affairs and International Trade, and the Canadian International Development Agency (CIDA). Internationally, interest in the Costa Rica–Canada Initiative continues to grow. Currently, 14 partner countries (including Argentina, Austria, Cameroon, Ecuador, Finland, France, Ireland, Japan, Malaysia, Norway, Spain, Switzerland, Turkey and Zimbabwe) are providing financial or logistical support, and the Intergovernmental Forum on Forests (IFF) Secretariat and the United Nations Food and Agriculture Organization (FAO) are providing advice.

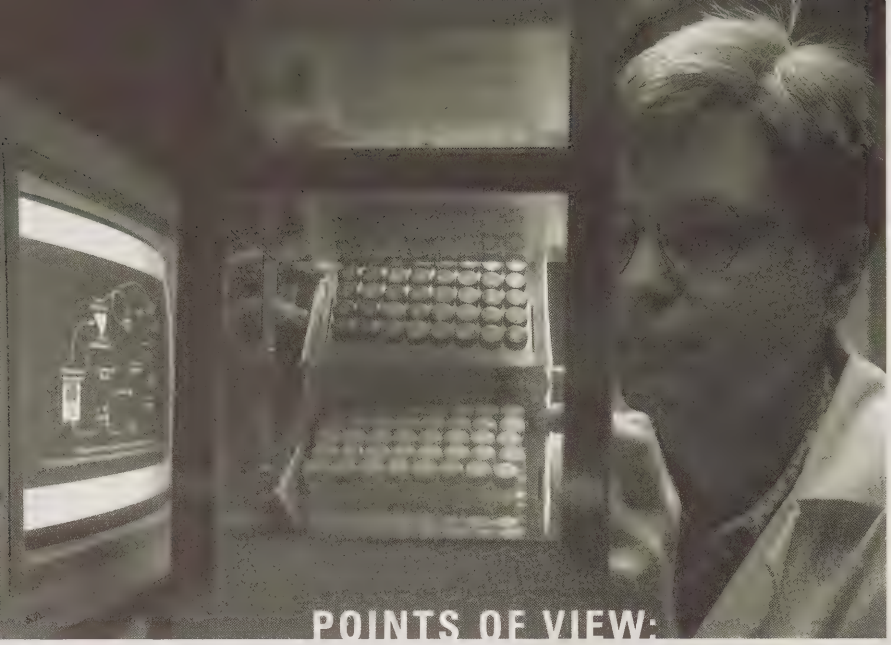
The Costa Rica–Canada Initiative is intended to be neutral, transparent, participatory and representative. At the first meeting—held in San José, Costa Rica, in February 1999—87 forest experts from more than 40 countries participated in an open exchange of views on the potential elements and relative merits of legally binding forest instruments. Later this year—from August to October—a series of regional meetings will be held at locations throughout the world to enable more than 700 forest experts to share their views and to analyze various options.

The findings from the Initiative will be consolidated in December 1999, at an international meeting hosted by Canada, and the results will be tabled at the final session of the IFF in February 2000. The IFF will then table its recommendations at the eighth session of the United Nations Commission on Sustainable Development (UNCSD) in April 2000, where decisions on further actions are expected to be made.

Further information on the Costa Rica–Canada Initiative is available on the Internet (http://www.nrcan.gc.ca/cfs/crc), including the dates, locations and reports of the regional meetings.

SPEAKING OUT

A cross-section of views regarding the **IMPACT** of technology on the forest sector.



POINTS OF VIEW:
HOW HAS TECHNOLOGY AFFECTED THE FOREST SECTOR?

Technology in all its guises—from office computers to the latest satellite-linked remote sensing equipment—has had, and will continue to have, a major impact on everyone working in the forest sector—from the forest technician to the president of a sawmill. In a rare demonstration of consensus among forest stakeholders, our interviewees all agreed wholeheartedly with this statement.

Not only are the interviewees responding to changes brought on by technology, but they have also modified their operations in response to its impact. Everyone emphatically stated that they have to keep up with technology to remain competitive. The belief in the necessity for life-long learning was underlined by all (not just by the educators in the group), because the rate of change is so rapid.

As well, all the interviewees mentioned two new technologies that have revolutionized the mechanization of harvesting in recent years: geographic information systems (GIS) and global positioning systems (GPS). Educators must know how to teach the use of these technologies, foresters must know how to use them, and scientists must know how to interpret the data.

Whether they represented academia, corporations, sawmills, small operations or government, the interviewees all agreed that the new technologies have significantly changed the classroom, the workplace and forest operations.

GEOFF MUNRO IS DIRECTOR OF THE SCIENCE DEVELOPMENT AND TRANSFER BRANCH OF THE ONTARIO MINISTRY OF NATURAL RESOURCES.

The impact of technology on Mr. Munro's branch reflects the restructuring of Ontario's forest program that began in 1996. The Branch, like much of government and industry these days, is trying to do more and more with less and less. Technology offers part of the solution—helping the Branch accomplish its work and lower costs by reducing the time required for routine tasks.

To pursue a forest activity in Ontario, an approved forest management plan is needed, usually written by 1 of the province's 54 sustainable forest licence holders. Using technology to help produce those plans and integrate the science that supports them are two areas where technology has had a significant impact.

At a general level, technology has also changed the office environment to the point that shorter delivery times and greater productivity are expected. The capability to use GIS is a specialty this land-based organization depends on. "Understanding what we have on the land base and where it is, and being able to correlate that information to the operational or planning decisions we are making is a very critical component." GIS enables the Branch to be more accurate about what is on the ground, and it correlates one set of issues to another, such as land ownership patterns to forest type and harvesting possibilities to habitat. Operations that are awkward to do with physical maps can be done with GIS.

In the field, the Branch is also using GPS to accurately describe where a fire has burned a forest. Someone can drive or fly the perimeter of a fire, and using a GPS unit, they can precisely identify where the fire has affected the forest. That same technology is being used in timber cruising and in a lot of conservation officer work. "GPS is becoming a much bigger piece of our work; I don't believe we've exhausted the potential of that technology—we're probably just scratching the surface."

Forest management has grown from our historical perspective of timber only, to timber being just one of the forest values society wants. This situation has resulted in a very complicated multi-variant modeling system. "We try to understand not only what all the pieces of the forest ecosystem are and how they interrelate, but also what the impact is of doing something in the forest—the impact on all values: economic, biological and social. Our ability to model those activities in an electronic form has helped us understand that we do not know all the answers, but it also gives us a significant leg up on our ability to understand some of those relationships and to put a cause and effect relationship together in a model to help guide forest management decisions."

The expectation for Branch employees is that a certain skill level is needed to operate the tool that comes with the job, whether they are a forester, a technician or someone trained in a specialty area. Mr. Munro looks at technology as an intrinsic part of the work environment. "We expect the entry-level worker to have a general skill set. We also have specialty requirements, such as GIS."

One of the great challenges is to overcome the divide between information management and science. "If we don't take the large amount of information that we gain from forest scientists and use it properly—which means making it readily accessible in a fashion that a forest manager can use it to support decision making, which means storing it properly and organizing it properly—then this information will not have a lot of value. But if we do all these things and also make the information available to the public, then clearly we are making the information gained through our investments in science work for us." He would like to see information management and the new knowledge that science provides working hand-in-hand, tied together, accessible and usable.

LARRY BOWERSOCK IS SAWMILL COORDINATOR AT THE HI-ATHA SAWMILL DIVISION OF WELDWOOD OF CANADA, LOCATED IN HINTON, ALBERTA.

There has been a great deal of technological impact in the sawmill—computers and process-control systems are being used throughout mills. In fact, Mr. Bowersock noted that sawmilling has become much more of an information-generated business. For instance, real-time updates are standard in terms of production, log-size recovery and piece counts. "It's not a 'wait until the end of the day and see what happens' sort of timing any more," he noted. "We can focus on individual machines minute by minute to make any necessary adjustments or changes in how we're doing things, or to do some equipment maintenance—all in a much more time-sensitive manner." Technology is used more and more to maximize the products obtained from a log, which means there will be a greater focus on increasing recovery. Another example are the systems available that enable lumber to be dried in the correct amount of time and not be over dried. "The new machines are maximizing the return from our logs based on information that is being generated through computer systems that track every log that comes through here, so we are making the correct decisions on every log." As well, computers are frequently being used to generate daily, weekly and monthly maintenance and preventative maintenance schedules. This maintenance scheduling aspect of the sawmilling and forest industry has increased tremendously in the past 15 years.

Electricians now have a much more expanded role in the sawmilling industry than they had in previous years. "In the past, they would set and reset motors and that sort of thing. Now electricians are programming machines—their job has become more specific and critical." Welders and millwrights are still required because it is a heavy industry, but electricians are much more essential to the success of sawmill operations than they were before.

Training is now being delivered more often through computers and electronic self-learning programs, for example, through CD-ROM-based lumber grading and drying courses or through computer-delivered, interactive management-analysis programs. Human trainers, however, have not disappeared. Mill operators prefer to have a supplier representative sit down with the employees who will be working on the equipment to go over the machine with them.

Sawmills can now focus on quality control for finer by-products that once were regarded as waste material. Supplying chips to pulp mills has become an integral part of HI-ATHA's business, and customers are demanding a high quality of chip to make good pulp. In fact, they are demanding a quality that is no different from the quality that lumber buyers are demanding. Technology and proper maintenance of the machinery are enabling the mill to meet these new requirements.

Technology is also having an effect on the average mill worker. Those working on the mill floor soon will need to have a general knowledge of computers and software applications. Mr. Bowersock observed, "Years ago, a lot of the sawmill work force might not have had grade 12, but they will need it in the future, and maybe also a technical degree."

Because of improvements in technology and systems, mills can produce more lumber; but trying to make more pieces faster puts pressure on the employees. However, technology is also helping the worker ergonomically. At the HI-ATHA mill, automatic grading booths have been installed that have transformed the job of lumber grading and sorting from a physical job into a "mental" job. These machines have helped create safer, more comfortable working conditions. And this seems to be a trend—sawmill jobs will involve more decision making and less hands-on labour.

Mr. Bowersock concluded by saying, "There will be more frequent change and more frequent upgrades. This will result in a greater focus on training so that workers can maintain their ability to work with new and different equipment."

BLAKE BRUNSDON IS CHIEF FORESTER AND PAUL ORSER IS A FORESTRY BUSINESS ANALYST AT J.D. IRVING LIMITED IN SAINT JOHN, NEW BRUNSWICK.

Technology has improved J.D. Irving Limited's competitiveness. According to Mr. Brunsdon, "You have to keep up with technology to stay efficient and maximize your productivity and quality control." Keeping up with technology is the only way to stay in business, although it requires higher capital investment and costs. However, when Mr. Brunsdon thinks of technology, he thinks of two types: information technology, and equipment improvement or process improvements. Mr. Orser agreed, saying that fitting the two together is the greatest challenge.

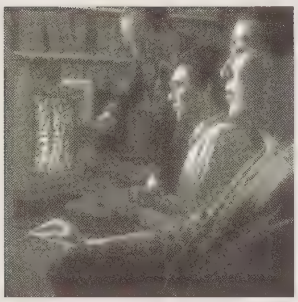
Technological improvements have created smaller, more fuel-efficient harvesting equipment that has a lighter environmental footprint, is more productive and faster, has a longer reach, and is safer. Mr. Brunsdon said, "Technology has enabled us to work in the forest more efficiently, so that we can get better utilization and optimized products, and ensure sustainability. Working in the woods today is safer and possibly more challenging and satisfying."

GIS and GPS give foresters the capability to obtain timely and more accurate information, for example, tighter inventory control, more detailed knowledge about costs and productivity, very accurate forecasting and wood-supply modeling, and more accurate

predictions of sustainable harvest levels. Computers and GIS technology facilitate doing "what if" scenarios. "Twenty years ago, you wouldn't dare ask for such analyses, because it would take someone years to do it. Today, you can test 'what if' scenarios and get answers three or four hours later. Although technology will tell you that you can do all these things, to actually execute them on the ground to the 'what if' level can create a performance gap between theory and practice." At the same time, the more a company can generate accurate information, the more the public demands it, and the more accountable a company is expected to be. The degree of accuracy wanted is keeping step with the technology. Harvesters are now required to be more precise in planning and implementing operations.

The two men agreed that the greatest impact of technology has been on people. "On the ground, the biggest impact is how to run these technologies, and from a management perspective, the challenge is how to sort out the information to get at what's important."

The company now looks for employees who can use more sophisticated technology and function well in an ever-changing environment, and who are open to ongoing learning and are comfortable working in a team environment. "We want people—specialists and generalists—who are comfortable with computers." They added, "The days of quitting school and working in the woods are no longer an option. You need at least a vocational skill set today." Mr. Orser continued, "At one time, working in the forest was a more physical activity, relying on strength and stamina. The forest worker today relies on education, training and use of the technology itself. These operations are miles from support centres. As a result, an operator has to be trained to maintain, troubleshoot and repair equipment. This training builds on the worker's high school and, often, college background."



Canada's great asset—its northern fibre—previously provided the forest industry with a competitive advantage. However, technology has enabled mills in other parts of the world to use lower quality fibre and lower inputs to produce quality products without using Canada's fibre. In places where they can grow trees five times faster than in Canada and where they pay lower wages, the only way for Canada to stay competitive is to use technology to hone every possible advantage from its fibre. "Technology is pushing us out of the running, but we must use it to stay in the running in some ways," concluded Mr. Brunsdon.

PROFESSOR MICHEL DESSUREAULT IS DEAN OF THE FACULTÉ DE FORESTERIE ET DE GÉOMATIQUE AT LAVAL UNIVERSITY IN QUEBEC.

Dean Dessureault observed that over the past 10 years, technology has changed both what they teach and how they teach in his faculty at Laval. During that time, computer use has become widespread, and more recently, all kinds of specialized computer tools and software—GIS, decision-making tools and communication tools—have become available. In 1995, courses in communications and new technologies were added. Representatives of the Quebec forest industry, noting that foresters had to interact more with the public, asked for these courses.

The Faculty is using computer tools and software more and more, particularly specialized forestry-related software. As well, the instructors are using computers as teaching tools and to demonstrate new skills. For example, more professors are creating Web sites to complement their courses and some have become quite proficient in making these sites. Although not all of the professors are embracing the new technologies, faculty members are helping each other learn about and use them. The new technologies have also affected hiring: "We used to have a lot of forest technicians working for us, now we realize we need more computer specialists."

Dean Dessureault noted that if educators are not at the forefront of these new technologies, they are not doing their job to give students the latest knowledge and skills available. "We like to see ourselves as being in front of the pack."

It is just a matter of time before the Faculty embraces distance learning. "We are being asked more and more to use these new technologies as teaching tools for continuing education. I know a few courses could almost be taken without the teacher being present. We don't want to go that far yet, but it would be possible."

The Faculty is committed to helping professional foresters and technicians gain the skills, such as using GIS, that they need to find and keep jobs in the forest industry. Continuing education courses are offered both at Laval and around the province. However, it is sometimes difficult to go outside the University to find the number of students needed to break even on the costs. The Faculty decided it would be more economically feasible to offer distance learning. It is also exploring teleconferencing. Having the teacher in one place and the students in smaller groups in other places can be cost effective. "Although you are not physically in the room with the teacher, at least you can interact with the teacher in real-time. It doesn't carry the drawbacks of distance learning done through written materials or computers."

Dean Dessureault sees both benefits and drawbacks to this type of learning. One of the benefits is that the Faculty can impart a lot more information with these new tools. Students can interact at their own pace, and they can learn the minimum required or go as far as they wish in exploring a subject. For example, powerful computer programs have been designed to let students try "what if" scenarios. However, Dean Dessureault fears the loss of personal contact between teachers and students, which is a risk when using the new technologies. Keeping up with the latest technologies is also a burden on the budget. It is very expensive to develop the infrastructure, especially when technologies change so rapidly.

When Dean Dessureault looks into the future, he sees the day when students will come to Laval with their own personal portable computer. "Students will come into a room with a teacher, and everyone will have to plug their computer into the wall and interact with the teacher through their computer. We have plans already to design rooms to do that. In the near future, we will require students to have their own computer."

GERALD GUENKEL IS DIRECTOR OF THE SCHOOL OF FORESTRY AT SIR SANDFORD FLEMMING COLLEGE IN LINDSAY, ONTARIO.

Over the past 10 years, Mr. Guenkel has seen a definite shift in the way the faculty is teaching due to the impact of technology. In the past, the teachers dictated the way material would be given, for example, a traditional lecture presentation with a lab component. Now the School is progressing toward more computer-based training, on-line courses combined with CD-ROM-delivered information, and hard-copy correspondence courses. It is exploring how to maintain the hands-on training that it prides itself on while using technology to help meet the two major concerns of students: life-long learning opportunities and keeping their costs as low as possible while obtaining a post-secondary education. For the instructors, however, the bottom line is human interaction. Hands-on instruction is still very valued, especially in such subjects as compassing, ecosystem assessment, planting quality, and proper and safe harvesting approaches. "Some of our best teachers may not be interested in technology. Yet, they are effective communicators."

The faculty has developed a distance learning course in forest pathology, entomology and dendrology. Mr. Guenkel says putting the material on-line is challenging because the presentation must be designed differently, and it takes a lot more effort to organize and often requires special equipment. "We have just purchased MPEG (a computerized file format used for video) cameras that allow up to one minute of video to be put on disk. We can now, for example, show a leaf and then rotate it to illustrate key details while the instructor speaks."

One of the School's goals is to help industry and the work force remain at the forefront by training students to work confidently with these new technologies. The School would eventually like to provide short courses and just-in-time courses, and even offer upgrade training to industry. "We want to start looking at ways to train for life-long learning." Industry will be able to hire better-educated employees who can make better resource decisions that will be environmentally responsible and cost-effective.

As the School explores how Web-based and computer-based training can be effective in teaching, Mr. Guenkel has some concerns: "How should these new learning approaches be used to help students effectively gain technological skills? How do educational institutions deliver these new approaches? How are the hands-on courses dealt with? There are many questions." Distance learning is good for students who cannot afford to be on campus for a semester. However, students must be self-disciplined enough to do the lessons on their own. Also, an instructor teaching in front of students can communicate excitement about a topic. "How can we get this across on screen? We love what we do, and students appreciate the faculty's solid expertise."

Twenty-five years ago, forestry students just had to buy a slide rule and a dot grid to calculate area on the ground. "Technology now costs the College a lot of money because the equipment must be rotated every three or four years. We have 7 labs and 210 computers to replace. This means a lot of money invested in our efforts to meet the demands of industry for quality students." The School would like to have more direct

connections with industry to enable students to obtain more hands-on experience with the equipment and technologies.

In the future, there will be an even faster pace of change. The Internet will globalize education, and as a result, the School is beginning to assess the Internet for marketing and delivering courses.

"It's exciting. Technological improvements will make for a better forest in the long run because people can make more educated decisions than they could before. For example, in the past it would have taken two weeks to develop one forest management scenario, now you can make eight scenarios in a short time. This enables better decisions to be made for our forests in the long run." Mr. Guenkel concluded by saying that the goal of using the new technologies is to keep our forests healthy well into the new millennium.

HARRIS HILTZ OF SPRINGFIELD, NOVA SCOTIA, IS A WOODLOT OWNER, CHRISTMAS TREE PRODUCER, HARVESTING CONTRACTOR AND REGISTERED COOPERATOR WITH THE NOVA SCOTIA DEPARTMENT OF NATURAL RESOURCES.

Mr. Hiltz has been an independent operator for 23 years. However, he has seen the greatest impact of technology on the way he does his job over the past five years. Increased reliance on computers, he believes, has given the small contractor an edge and higher productivity. He can estimate his costs more accurately, which is crucial in the highly competitive forest industry of the 1990s. For example, computer programs help demonstrate a good costs scenario. "In the woods, there's so many different weather conditions, stand types, etc., so if you're off a half-gallon of fuel per hour that can add up to big bucks at the end of the season."

Mr. Hiltz now uses computer programs for payrolls, records, etc., in place of handwritten ledgers and journals. However, there is more paperwork and a lot more information to deal with. As well, he can see using the Internet more and more to sell his trees and services.

At one time, he could hire a few people to go out with a skidder and produce wood and usually have some money left over. "About eight years ago," Mr. Hiltz reminisced, "I was into a feller-buncher mechanical operation, grapple skidding, whole-tree harvesting with wood chip vans. I was running 24 hours a day, 7 days a week. By the end of the year I was burned out and had nothing left."

Computerized harvesters have helped industry keep costs down, he observes. As well, instead of hiring five people, only one or two people are needed to run these new machines, which helps reduce costs. However, it is harder to find competent employees who can work the new machinery and to pay them a high enough salary to keep them on the job.

"You need a big bank loan or a lot of capital invested in your equipment. Instead of paying $600 for a power saw, you pay half a million dollars for a machine plus its support system." Because of the large capital cost, an operator needs a large volume of wood, and

to have that, one must enter into a partnership with a larger company. "Some of these partnerships work and some don't," he observed.

As well, computerized equipment is not as versatile as a person running a power saw. The computerized machines cannot cut in some of the stand types, terrain types, etc. that a person on the ground can. However, machines will work rain or shine, and the technology has reduced labour problems.

Twenty years ago, there was less emphasis on training because people were not aware of the safety costs. "Now with computers, we know what accidents cost a company. With the workman's compensation rate going higher in Nova Scotia, I put more emphasis on safety training because it's hurting me in the pocketbook." He hires people who have a good work ethic and are interested in the job and then he trains them. Good forest workers, in his opinion, must be aware of what they are doing, have a good attitude, be aware of the forest and how it grows, be aware of environmental issues, and be good public relations people.

In the future, Mr. Hiltz would like workers to be better paid, better trained in the new technologies and more conscientious. Hopefully, he noted, technology will be part of ongoing training. If they do not learn on the job, they will not be viable employees.

Technology gives industry a great advantage; however, for small operators it is sometimes a problem. "We are competing with pulp mills in Brazil that produce at lower cost, but sell to the same customers in Europe. Without technology in Nova Scotia, maybe our mills would have closed and gone to Brazil. The use of technology becomes a vicious circle."

STEVE SILVEIRA IS SENIOR VICE-PRESIDENT OF OPERATIONS WITH THE AINSWORTH LUMBER COMPANY IN BRITISH COLUMBIA.

Technology has had a great impact on the company's competitiveness, especially in wood recovery. "Wood, particularly in British Columbia, is the highest cost input in our industry. Getting more out of the resource is critical. Anyone not using the latest technology will not be competitive," Mr. Silveira noted.

A lot less wood is used to produce a product today. Smaller saw kerfs and better lumber size control, due to computer technology, mean that there is very little waste. "We are using more of the tree. We are getting more out of a given cubic metre of wood, and less of it is going into sawdust or refuse. There is high product consistency and quality and less human error. More wood products are being engineered, such as wood I-joists. Much less wood is used to replace traditional solid lumber products."

Technology is also improving safety in the woods and mills. "In B.C. today, people are working less on the ground, they are inside comfortable, safer cabs. There is less physical contact between the worker and the wood." However, technology tends to reduce manual labour and, with it, the number of jobs.

Technology has also increased biological sustainability by improving harvesting productivity in small stands. Companies can now use smaller stems and smaller stands of

trees than before, as well as species that traditionally were not part of the resource. A classic example are the vast aspen forests found across Canada that were previously considered a non-commercial species, until technology brought us engineered wood products and further mechanization of harvesting."

Computer technology is affecting everyone and giving employees better information and tools. "If you are not computer literate, you are really handicapped. Some of our older workers are having a tough time, but the younger ones are making the effort to become computer literate." More rigorous training is required to put workers in these new jobs. In the mill, Mr. Silveira sees a need for people who have stronger backgrounds in computer process control. The company is hiring a higher level of skilled worker with a minimum of grade 12. "Even if you're just going out in the bush cruising, you will probably use hand-held computer instruments to collect data, and you're going to need the knowledge of how they work," he noted.

Using GIS enables the company to handle large amounts of information on logged areas, including silviculture work and harvesting histories, post-harvesting treatments and how reforested stands are progressing. "We can sort records on our work history to see what is ahead of us, which was previously impossible." GIS enables the land base to be managed using a lot more variables and asking many more questions. GIS is becoming an even more powerful tool as it is being integrated with satellite systems that can produce real-time information.

A drawback to using computerized equipment is that it requires careful handling; workers cannot throw it in the back of a truck like a shovel. "We have become dependent on our technology. Forest workers now rely on technicians to repair new machinery instead of being able to do it themselves. Reliability is a problem; when a computer goes, everything goes down."

In the future, different combinations of recovery and product values will be looked at over a broader range of the process, and more of the process will be controlled by computer decisions. "Technology will integrate the process from the bush to the end-product—which logs are being brought into the mill, at what prices, and at what potential grade recovery—and will then break the log into those products and find the markets for them. That's where we're going. It isn't the complete solution, because once you're in it, it's quite theoretical and you lose your ability to instinctively know if it's the right direction. However, at some point, we have to trust computer technology to provide solutions we can't do on paper."

ABORIGINAL RIGHTS Rights that some Aboriginal peoples of Canada hold as a result of their ancestors' long-standing use and occupancy of the land. The rights of certain Aboriginal peoples to hunt, trap and fish on ancestral lands are examples of Aboriginal rights. Aboriginal rights will vary from group to group depending on the customs, practices and traditions that have formed part of their distinctive cultures.

ABORIGINAL TITLE A legal term that recognizes the interest of Aboriginals in the land. It is based on their long-standing use and occupancy of the land as descendants of the original inhabitants of Canada.

BIOASSAY A technique for determining the effectiveness of a substance by measuring its effects on animals, tissues or organisms and comparing them to the effects of a standard preparation.

BIOTECHNOLOGY Development of products by a biological process. Production may be carried out by using intact organisms (e.g., yeasts and bacteria) or by using natural substances (e.g., enzymes) from organisms.

CLIMATE CHANGE An alteration in measured quantities (e.g., precipitation, temperature, radiation, wind and cloudiness) within the climate system that departs significantly from previous average conditions and is seen to endure, bringing about corresponding changes in ecosystems and socioeconomic activity.

COMMERCIAL FOREST Forest land that is able to grow commercial timber within an acceptable time frame and is designated for such a purpose.

CONIFEROUS Refers to a forest stand or category of trees or bush that is popularly called "evergreen." The wood of conifers is commercially known as "softwood."

CONVENTION A legally binding agreement, often among many parties.

CROWN LAND Public land that is managed by the federal or provincial/territorial government.

DENDROLOGY (FOREST) The study of trees; tree identification.

ECODISTRICT A part of an ecoregion characterized by distinctive geologic, soil, water, fauna and land use.

ECOLABELING A two-step process used to determine when a product can display a special seal or mark signifying that it is less harmful to the environment than most other similar products. The two-steps are: establishment of criteria, and certification that a product meets the criteria.

ECOREGIONS A part of an ecozone characterized by distinctive regional ecological factors, including climate, physical geography, vegetation, soil, water, fauna and land use.

ECOSYSTEM A dynamic system of plants, animals and other organisms, together with the non-living components of the environment, functioning as an interdependent unit.

ECOTOURISM A type of tourism that focuses on nature-related experiences (e.g., whale watching).

ECOZONE A broad-scale ecological unit that is based on patterns that include climate, geography and ecological diversity. The ecozone lies at the top of the ecological hierarchy.

ENGINEERED WOOD PRODUCTS A composite wood product made from glued fibre, lumber and/or veneer to meet specific design criteria.

EVEN-AGED FOREST A forest stand or type in which relatively small age differences (10–20 years) exist between individual trees.

FOREST A complex community of plants and animals in which trees are the most conspicuous members. A mixed forest includes both coniferous and deciduous trees.

FOREST CANOPY The more or less continuous cover of branches and foliage formed collectively by the crowns of adjacent trees.

FOREST LAND Land primarily intended for growing, or currently supporting, forest. It includes land not now forested (e.g., clearcut lands and northern lands that are forested but not intended for any commercial forestry use) and plantations.

FORESTRY PRACTICES Any activity that is carried out on forest land to facilitate the use of forest resources, including, but not limited to, timber harvesting, road construction, silviculture, grazing, recreation, pest control and wildfire suppression.

GEOGRAPHIC INFORMATION SYSTEM (GIS) An organized collection of computer hardware, software and geographic data designed for capturing, storing, updating, manipulating, analyzing and displaying all forms of geographically referenced information.

GLOBAL WARMING The rise in temperature of the Earth's atmosphere due to the greenhouse effect (the retention of the sun's energy by the atmosphere due to the build-up of CO_2 and other gases that are the by-product of industrial activities).

GLOBAL POSITIONING SYSTEM (GPS) A system of satellites and receiving devices used to compute positions on the Earth.

GREEN TREE CUT (RETENTION SYSTEM) Harvesting that retains live trees of a specific species and size on the area to be cut to achieve a site-specific objective.

GROSS DOMESTIC PRODUCT (GDP) A measure of national income–the amount paid to Canadians in terms of salaries, wages, profits and taxes.

HARDWOOD (TREES) Broad-leaved trees; also refers to the wood produced by these trees. Hardwoods belong to the botanical group angiospermae and are the dominant type of tree in the deciduous forest.

INNOVATION The use of a new idea, material or technology to produce new goods or services or to change the way in which goods or services are produced or distributed. Innovation can include improved managerial systems, new production techniques, new technology, the results of research and development, or the application of information technologies.

INVENTORY (FOREST) A survey of a forest area to determine such data as area, condition, timber, volume and species for a specific purpose, such as planning, purchasing, evaluating, managing or harvesting.

MICRO ORGANISM A microscopic one or multi-celled organism, such as a bacterium, virus, yeast, alga, fungus or protozoan.

NON-COMMERCIAL TREE SPECIES A tree species for which there is currently no market.

NON-TARIFF BARRIER An economic, political, administrative or legal impediment to trade other than a duty, tax or import quota.

NON-TIMBER RESOURCE VALUE A value within the forest other than timber that includes, but is not limited to, biological diversity, fisheries, wildlife, minerals, water quality and quantity, recreation and tourism, cultural and heritage values, and wilderness and aesthetic values.

OLD-GROWTH FOREST A forest dominated by mature trees that has not been significantly influenced by human activity. The stand may contain trees of different ages and various species of vegetation.

OPEN FOREST Proposed name for the natural forest commonly found in northern Canada. This forest is a mixture of wetlands and small trees, occasionally interspersed with highly productive forests.

PARTIAL CUTTING Tree removal other than clearcutting, i.e., taking only part of a stand.

PATCH CUTTING The removal of all of the trees in a stand. The same as clearcutting, except that the area involved is smaller.

PATHOLOGY (FOREST) The study of disease.

PEST An organism capable of causing material damage. Forest pests include insects, tree disease and noxious fungi.

PHENOLIC (PHENOLIC COMPOUND) A highly complex organic compound that exists in every plant in various mixes, ratios and concentrations. Phenols include, for example, many plant pigments.

PHEROMONE A chemical substance released by animals, including insects, that influences the behaviour or development of other individuals of the same species, e.g., sexual attractants.

PLANTATION A stand of trees that has been grown through direct seeding or by planting seedlings.

PRE-COMMERCIAL THINNING Cutting in an immature crop or stand to improve crop spacing and to accelerate the diameter increment of favoured trees, and/or improve the average form of the trees that remain. Does not yield trees of commercial value.

RESEARCH AND DEVELOPMENT (R&D) Set of activities directed toward improving and innovating products and processes from a technological point of view and not from a commercial point of view. Encompasses basic research, applied research and development.

SCIENCE (FOREST) The study of the material universe or physical reality in order to understand it. This is done by making observations and collecting data about natural events and conditions, then organizing and explaining them with hypotheses, theories, models, laws and principles.

SCIENCE AND TECHNOLOGY/S&T (FOREST) Systematic activities that are closely concerned with the generation, advancement, dissemination and application of scientific and technical knowledge in all fields of science and technology, including such activities as research and development (R&D), scientific and technical education and training, and scientific and technological services.

SILVICULTURE The theory and practice of controlling the establishment, composition, growth and quality of forest stands. Can include basic silviculture (e.g., planting and seeding) and intensive silviculture (e.g., site rehabilitation, spacing and fertilization).

SOFTWOOD (TREES) Cone-bearing trees with needles or scale-like leaves; also refers to the wood produced by these trees. Softwoods belong to the botanical group gymnospermae and are the predominant tree type in coniferous forests.

STEWARDSHIP (FOREST) Environmentally and socially responsible use, management and development of forest resources to maintain and enhance the value of the forest for present and future generations.

STUMPAGE FEE The fee paid by an individual or company for the timber they harvest from public forests or privately owned forest land.

SUSTAINABLE FOREST MANAGEMENT Management that maintains and enhances the long-term health of forest ecosystems for the benefit of all living things while providing environmental, economic, social and cultural opportunities for present and future generations.

TARIFF An import tax or a list of articles and the import tax that must be paid on items on that list. A protective tariff is meant to protect local businesses from foreign competition; a retaliatory tariff is in response to a foreign country's tax on goods from your country; and an antidumping tariff is to prevent foreign countries from selling their goods in the importing country at a lower price than the goods sell for in the foreign country or at a price lower than the manufacturing cost.

TRANSGENIC (PLANT) Genetically engineered plant or offspring of genetically engineered plants.

VALUE-ADDED (PROCESSING) Adding value to a product by further processing it. Examples of value-added wood products include joinery stock, windows, doors, kitchen cabinets, flooring and mouldings. Value-added pulp and paper products include such items as packaging, diapers, coated papers, tissue, business papers and stationery, and other consumer paper products.

CONTACTS

The following organizations can provide more information about Canada's forest resources and its commitment to achieving sustainable forests.

NATIONAL FOREST STRATEGY COALITION

National Forest Strategy Coalition Secretariat
Sir William Logan Building, 8th floor
580 Booth Street
Ottawa ON K1A 0E4
Phone: (613) 947-9087
Fax: (613) 947-9038
E-mail: nfsc.csnf@nrcan.gc.ca
Internet site: www.nfsc.forest.ca

Alberta Forest Products Association
200–11738 Kingsway Avenue
Edmonton AB T5G 0X5
Phone: (780) 452-2841
Fax: (780) 455-0505
E-mail: afpinfo@compusmart.ab.ca
Internet site: www.abforestprod.org

Alberta Registered Professional Foresters Association
5320–122 Street
Edmonton AB T6H 3S5
Phone: (780) 432-1177
Fax: (780) 432-7046
E-mail: arpfa@nrcan.gc.ca
Internet site: www.arpfa.org

Association of British Columbia Professional Foresters
1201–1130 West Pender Street
Vancouver BC V6E 4A4
Phone: (604) 687-8027
Fax: (604) 687-3264
E-mail: guest@rpf-bc.org
Internet site: www.rpf-bc.org

Association of Registered Professional Foresters of New Brunswick
Hugh John Flemming Forestry Centre
1350 Regent Street
Fredericton NB E3C 2G6
Phone: (506) 452-6933
Fax: (506) 450-3128
E-mail: arpf@nbnet.nb.ca

Association of University Forestry Schools of Canada
Dr. Rorke Bryan
University of Toronto
Faculty of Forestry
33 Willcocks Street
Toronto ON M5S 3B3
Phone: (416) 978-5480
Fax: (416) 978-3834
E-mail: r.bryan@utoronto.ca

Canadian Federation of Woodlot Owners
180 St. John Street
Fredericton NB E3B 4A9
Phone: (506) 459-2990
Fax: (506) 459-3515
E-mail: nbfwo@nbnet.nb.ca

Canadian Forestry Association
203–185 Somerset Street West
Ottawa ON K2P 0J2
Phone: (613) 232-1815
Fax: (613) 232-4210
E-mail: cfa@cyberus.ca

Canadian Institute of Forestry
606–151 Slater Street
Ottawa ON K1P 5H3
Phone: (613) 234-2242
Fax: (613) 234-6181
E-mail: cif@cif-ifc.org
Internet site: www.cif-ifc.org

Canadian Pulp and Paper Association
Édifice Sun Life, 19^{e} étage
1155, rue Metcalfe
Montréal QC H3B 4T6
Phone: (514) 866-6621
Fax: (514) 866-3035
E-mail: communic@cppa.ca
Internet site: www.open.doors.cppa.ca

Canadian Silviculture Association
c/o Brinkman and Associates Reforestation
520 Sharpe Street
New Westminster BC V3M 4R2
Phone: (604) 521-7771
Fax: (604) 520-1968
E-mail: brinkman@brinkman.ca

Canadian Wildlife Federation
2740 Queensview Drive
Ottawa ON K2B 1A2
Phone: (613) 721-2286
Fax: (613) 721-2902
E-mail: info@cwf-fcf.org
Internet site: www.cwf-fcf.org

Council of Forest Industries
1200–555 Burrard Street
Vancouver BC V7X 1S7
Phone: (604) 684-0211
Fax: (604) 687-4930
Internet site: www.cofi.org

Ducks Unlimited Canada
PO Box 4465
Regina SK S4P 3W7
Phone: (306) 569-0424
Fax: (306) 565-3699
E-mail: d_chekay@ducks.ca
Internet site: www.ducks.ca

Forest Alliance of British Columbia
1055 Dunsmuir Street
PO Box 49312
Vancouver BC V7X 1L3
Phone: (604) 685-7507
Fax: (604) 685-5373
Internet site: www.forestalliance.org

Forest Engineering Research Institute of Canada
580, boulevard St-Jean
Pointe-Claire QC H9R 3J9
Phone: (514) 694-1140
Fax: (514) 694-4351
E-mail: admin@mtl.feric.ca
Internet site: www.feric.ca

FORINTEK Canada Corp.
2665 East Mall
Vancouver BC V6T 1W5
Phone: (604) 224-3221
Fax: (604) 222-5690
E-mail: info@van.forintek.ca
Internet site: www.forintek.ca

Gouvernement du Québec
Ministère des Ressources naturelles
10^{e} étage, 880, chemin Ste-Foy
Québec QC G1S 4X4
Phone: (418) 627-8652
Fax: (418) 646-3387
Internet site: www.mrn.gouv.qc.ca

Government of Alberta
Department of Environmental Protection
Petroleum Plaza South Tower, 10th floor
9915–108 Street
Edmonton AB T5K 2G8
Phone: (780) 427-3542
Fax: (780) 422-6068
Internet site: www.gov.ab.ca

Government of British Columbia
Ministry of Forests
1st floor, 1450 Government Street
Victoria BC V8W 3E7
Phone: (250) 387-6656
Fax: (250) 387-1467
Internet site: www.for.gov.bc.ca

Government of Manitoba
Department of Natural Resources
200 Saulteaux Crescent
PO Box 70
Winnipeg MB R3J 3W3
Phone: (204) 945-7989
Fax: (204) 948-2671
Internet site: www.gov.mb.ca

Government of New Brunswick
Department of Natural Resources and Energy
Hugh John Flemming Forestry Complex
PO Box 6000
Fredericton NB E3B 5H1
Phone: (506) 453-2614
Fax: (506) 457-4881
Internet site: www.gov.nb.ca/dnre

Government of Newfoundland and Labrador
Department of Forest Resources and Agrifoods
Natural Resources Building, 5th floor
50 Elizabeth Avenue
PO Box 8700
St. John's NF A1B 4J6
Phone: (709) 729-2704
Fax: (709) 729-3374
Internet site: www.gov.nf.ca/forest

Government of Nova Scotia
Department of Natural Resources
Founder's Square, 2nd floor
1701 Hollis Street
PO Box 698
Halifax NS B3J 2T9
Phone: (902) 424-5935
Fax: (902) 424-7735
Internet site: www.gov.ns.ca/natr

Government of Ontario
Ministry of Natural Resources
Whitney Block, Room 6540
99 Wellesley Street West
Toronto ON M7A 1W3
Phone: (416) 314-6131
Fax: (416) 314-1994
Internet site: www.mnr.gov.on.ca

Government of Prince Edward Island
Department of Agriculture and Forestry
Jones Building
11 Kent Street
PO Box 2000
Charlottetown PE C1A 7N8
Phone: (902) 368-4880
Fax: (902) 368-4857
Internet site: www.gov.pe.ca

Government of Saskatchewan
Department of Environment and Resource Management
3211 Albert Street
Regina SK S4S 5W6
Phone: (306) 787-2700
Fax: (306) 787-2947
Internet site: www.gov.sk.ca/govt/environ

Government of the Northwest Territories
Department of Resources, Wildlife and Economic Development
149 McDougal Road, PO Box 7
Fort Smith NT X0E 0P0
Phone: (867) 872-7700
Fax: (867) 872-2077
Internet site: www.gov.nt.ca

Government of the Yukon Territory
Department of Renewable Resources
10 Burns Road
PO Box 2703
Whitehorse YT Y1A 2C6
Phone: (867) 667-5237
Fax: (867) 393-6213
Internet site: www.gov.yk.ca

Industrial, Wood and Allied Workers of Canada
500–1285 West Pender Street
Vancouver BC V6E 4B2
Phone: (604) 683-1117
Fax: (604) 688-6416
E-mail: national@iwa.ca
Internet site: www.iwa.ca

Maritime Lumber Bureau
PO Box 459
Amherst NS B4H 4A1
Phone: (902) 667-3889
Fax: (902) 667-0401
E-mail: mlb@ns.sympatico.ca
Internet site: www.mlb.ca

National Aboriginal Forestry Association
875 Bank Street
Ottawa ON K1S 3W4
Phone: (613) 233-5563
Fax: (613) 233-4329
E-mail: nafa@web.net
Internet site: www.sae.ca/nafa

National Round Table on the Environment and the Economy
200–344 Slater Street
Ottawa ON K1R 7Y3
Phone: (613) 992-7189
Fax: (613) 992-7385
E-mail: admin@nrtee-trnee.ca
Internet site: www.nrtee-trnee.ca

Natural Resources Canada
Canadian Forest Service
Sir William Logan Building, 8th floor
580 Booth Street
Ottawa ON K1A 0E4
Phone: (613) 947-9087
Fax: (613) 947-9038
E-mail: ahrousse@nrcan.gc.ca
Internet site: www.nrcan.gc.ca

New Brunswick Forest Technicians Association
PO Box 9
Plaster Rock NB E0J 1W0
Phone: (506) 356-4199
Fax: (506) 356-4105

Nova Scotia Forest Technicians Association
32 Croweland Drive
RR 2
Truro NS B2N 5B1
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Richmond Hill ON L4B 1M8
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Fax: (905) 764-2921
E-mail: opfa@compuserve.com
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Ordre des ingénieurs forestiers du Québec
2750, rue Einstein, bureau 380
Sainte-Foy QC G1P 4R1
Phone: (418) 650-2411
Fax: (418) 650-2168
E-mail: oifq@mediom.qc.ca
Internet site: www.oifq.com

Prince Edward Island Nature Trust
PO Box 265
Charlottetown PE C1A 7K4
Phone: (902) 892-7513
Fax: (902) 628-6331
E-mail: intrust@isn.net

Pulp and Paper Research Institute of Canada
570, boulevard St-Jean
Pointe-Claire QC H9R 3J9
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Fax: (514) 630-4110
E-mail: wright@paprican.ca

Quebec Forest Industries Association
102–1200, avenue Germain-des-Prés
Sainte-Foy QC G1V 3M7
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Fax: (418) 651-4622
E-mail: info@aifq.qc.ca
Internet site: www.aifq.qc.ca

Quebec Lumber Manufacturers Association
200–5055, boulevard Hamel Ouest
Québec QC G2E 2G6
Phone: (418) 872-5610
Fax: (418) 872-3062
E-mail: info@sciage-lumber.qc.ca
Internet site: www.sciage-lumber.qc.ca

Registered Professional Foresters of Newfoundland and Labrador
Fortis Building
PO Box 2006
Corner Brook NF A2H 6J8
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Fax: (709) 637-2290

Wildlife Habitat Canada
200–7 Hinton Avenue North
Ottawa ON K1Y 4P1
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E-mail: receptio@whc.org

CANADIAN MODEL FOREST NETWORK

Canadian Model Forest Network Secretariat
580 Booth Street, 7th floor
Ottawa ON K1A 0E4
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E-mail: jpugin@nrcan.gc.ca
Internet site: www.modelforest.net

Bas-Saint-Laurent Model Forest
Université du Québec à Rimouski
300, allée des Ursulines, bureau J-463
Rimouski QC G5L 3A1
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Fax: (418) 721-5630
E-mail: fmodbsl@quebectel.com
Internet site: www.globetrotter.net/fmbsl

Eastern Ontario Model Forest
Ministry of Natural Resources Building
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PO Box 2111
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Fax: (613) 258-8363
E-mail: eomf@storm.ca
Internet site: www.eomf.on.ca

Foothills Model Forest
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Internet site: www.fmf.ab.ca

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Internet site: www.fundymodelforest.net

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E-mail: office@lamf.net
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Internet site:
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Prince George BC V2L 4W2
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Prince Albert SK S6V 7G3
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Internet site: www.pamodelforest.sk.ca

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INTERNATIONAL MODEL FOREST NETWORK

International Model Forest Network Secretariat
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Bureau of Land Management
Applegate Partnership
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Bosque Modelo Calakmul
(Calakmul Model Forest)
Ecologia Productiva
Calle Caobas S/N
Zoh-Laguna, Calakmul
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Bosque Modelo Mariposa Monarca
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Hayfork Model Forest
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E-mail: arykoff/r5_shastatrinity@fs.fed.us


Natural Resources Canada
Canadian Forest Service
Ressources naturelles Canada
Service canadien des forêts
FOREST REGIONS of CANADA
YUKON TERRITORY
NORTHWEST TERRITORIES
NUNAVUT
Hudson Bay
Pacific Ocean
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
QUEBEC
NEWFOUNDLAND and LABRADOR
PRINCE EDWARD ISLAND
NEW BRUNSWICK
NOVA SCOTIA
Atlantic Ocean
0 125 250 km
FOREST REGIONS
PRINCIPAL TREE SPECIES
BOREAL – PREDOMINANTLY FOREST
White spruce, black spruce, balsam fir, jack pine, white birch, trembling aspen
BOREAL – FOREST AND BARREN
White spruce, black spruce, tamarack
BOREAL – FOREST AND GRASS
Trembling aspen, willow
SUBALPINE
Engelmann spruce, alpine fir, lodgepole pine
MONTANE
Douglas-fir, lodgepole pine, ponderosa pine, trembling aspen
COAST
Western red cedar, western hemlock, Sitka spruce, Douglas-fir
COLUMBIAN
Western red cedar, western hemlock, Douglas-fir
DECIDUOUS
Beech, maple, black walnut, hickory, oak
GREAT LAKES – ST. LAWRENCE
Red pine, eastern white pine, eastern hemlock, yellow birch, maple, oak
ACADIAN
Red spruce, balsam fir, maple, yellow birch
GRASSLANDS
Trembling aspen, willow, bur oak
TUNDRA

CANADIAN FOREST SERVICE
National Science and Technology Networks

① CFS–ATLANTIC FORESTRY CENTRE
PO Box 4000
Regent Street
Fredericton NB E3B 5P7
Phone: (506) 452-3500 Fax: (506) 452-3525
Lead centre for the forest biodiversity and forest health networks. Associated with this Centre is a research unit in Newfoundland.

② CFS–LAURENTIAN FORESTRY CENTRE
1055, rue du P.E.P.S.
CP 3800
Sainte-Foy QC G1V 4C7
Phone: (418) 648-3957 Fax: (418) 648-5849
Lead centre for the tree biotechnology and advanced genetics network. Co-lead for the forest ecosystem processes network.

③ CFS–GREAT LAKES FORESTRY CENTRE
PO Box 490
1219 Queen Street East
Sault Ste. Marie ON P6A 5M7
Phone: (705) 949-9461 Fax: (705) 759-5700
Lead centre for the pest management methods network. Co-lead for the forest ecosystem processes network.

④ CFS–NORTHERN FORESTRY CENTRE
5320–122 Street
Edmonton AB T6H 3S5
Phone: (780) 435-7210 Fax: (780) 435-7359
Lead centre for the fire management, climate change and socioeconomics research networks.

⑤ CFS–PACIFIC FORESTRY CENTRE
506 West Burnside Road
Victoria BC V8Z 1M5
Phone: (250) 363-0600 Fax: (250) 363-0775
Lead centre for the landscape management and effects of forest practices networks.

HQ CFS HEADQUARTERS
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580 BOOTH ST
OTTAWA ON K1A 9Z9

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YOUR VIEWS ARE IMPORTANT ...

By taking a moment to complete this postage-paid feedback card, you will assist us in preparing future editions of *The State of Canada's Forests*, and will help ensure that readers are provided with the most relevant information on Canada's forests and its allied industries.

Reply by November 30, 1999 to receive a lapel pin commemorating the centennial of the Canadian Forest Service.

Ressources naturelles Canada
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Natural Resources Canada
Canadian Forest Service

READER FEEDBACK

Did *The State of Canada's Forests* provide a good general overview?
- ❑ Not enough detail
- ❑ Just the right amount of detail
- ❑ Too much detail

Did the report increase your understanding of forests and forestry in Canada?
- ❑ Increased my understanding a lot
- ❑ Increased my understanding a little
- ❑ No change

Were the statistics useful?
- ❑ Very
- ❑ Somewhat
- ❑ Not at all

Did you consider the statistics reliable?
- ❑ Very
- ❑ Somewhat
- ❑ Not at all

Was the report easy to read?
- ❑ Too technical
- ❑ Just right
- ❑ Too simple

Did you like the layout of the report?
- ❑ Well designed
- ❑ Difficult to follow

How much of the report have you read?
- ❑ All of it
- ❑ About half of it
- ❑ Less than a quarter of it

Which sections were of most interest to you?
- ❑ Longer feature articles
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- ❑ Forestry Statistics
- ❑ Profiles Across the Nation
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